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FURTHER STUDIES ON CEREAL RUSTS IN INDIA

PART II

BY

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Part II.

CONTENTS

GENERAL INTRODUCTION

THIS monograph has been written in continuation of monograph No. 14 [Mehta, 1940] dealing with physiologic races, the rôle of alternate hosts and oversummering in relation to the annual recurrence of rusts of wheat and barley in India. It gives an account of work on dissemination of rusts conducted up to the end of March, 1938 and also deals with some direct methods of control which, in the opinion of the writer, should help considerably in mitigating the heavy loss caused by rust eqidemics in hills as well as the plains of India year after year.

A preliminary study of rust dissemination was started by the writer in the year 1929 and the scope of this work was extended from time to time after 1930, with financial aid from the Imperial (now Indian) Council of Agricultural Research. The total amount of the grants made by the Council for three successive schemes of research amounted to Rs. 2,43,776 up to the end of March, 1938 and the study of rust dissemination was carried out with ,the help of the same staff as was engaged, from time to time, for work on the ereal-rust problem as a whole.

By the courtesy of the Directors of Agriculture in the various States, the Director, Imperial Agricultural Research Institute, Pusa (now at New Delhi), the Director, Institute of Plant Industry, Indore, the Professor of Botany, Government College, Ajmer, the Lecturer in Botany, St. Andrews College, Gorakhpur and the Lecturer in Biology, Agricultural Institute, Allahabad, arrangements were made for the exposure of stationary slides in aeroscopes for catching spores of rusts at a large number of stations scattered all over the country. Year after year, slides smeared with vaseline were also sent up on balloons and kites from the Upper-Air Observatory at Agra.

Slides from all stations were examined by members of the rust research staff stationed at Agra and Simla. Information regarding the dates of rust appearance was sent to Agra by the Superintendents-in-charge of Experimental Stations in the Provinces and States and by other workers, at the request of the writer. In addition, observations on the incidence of rusts at selected stations were occasionally made by the writer and some members of the rust research staff. During 1935-38 three more assistants were engaged for survey in some of the Provinces in co-operation with the writer. These assistants worked under the immediate supervision of the Professor of Botany, Agricultural College, Lyallpur, the Plant Pathologist to the Government of Bombay, Poona and the Government Mycologist, Coimbatore. During 1935-36 the Imperial* Mycologist, Pusa, kindly lent the part-time services of one of his fieldmen for this study at the foot of the Nepal range.

Working Charts for the preparation of wind-trajectories were kindly lent by the Director General of Observatories, Poona. For the preparation of wind-trajectories, an assistant with special knowledge of meteorology was engaged, to start with, for a period of four months in the year, but from 1935-38, one assistant was maintained throughout the year for this work. All wind-trajectories were prepared at the Upper-Air Observatory at Agra under the general surpervision of the Superintending Meteorologist.

With the expansion of the scope of work in the year 1938 arose the need of relief to the writer from a part of his duties at the Agra College and the Imperial (now Indian) Council of Agricultural Research very kindly allowed an adequate

* Now the head of the Division of plant Pathology of Indian Agricultural Research Institute.

sum, out of the grants mentioned above, for the appointment of a temporary Lecturer and a Personal Research Assistant. The writer wishes to express his warmest thanks to the authorities of the Agra College for the facilities provided for this study as well as for the relief granted to him from some of his duties as a whole-time member of the staff of that institution.

As stated in the previous monograph, the writer consulted Prof. F. T. Brooks, F.R.S. of the University of Cambridge, the late Sir Edwin J. Butler, F.R.S. formerly Secretary, Agricultural Research Council, London and Prof. E. C. Stakman of Minnesota, United States of America, from time to time during the progress of the investigations and wishes to express his most grateful thanks for their kind interest and helpful suggestions.

The writer also had the benefit of a personal discussion on the cereal-rust problem of India, relating specially to dissemination, with Prof. V. H. Blackman, F.R.S., London, the late Prof. A. H. R. Buller, F.R.S. of Manitoba and the late Sir Arthur Hill, F.R.S., Director, Royal Botanic Gardens, Kew, during their visit to the Rust Research Laboratory at Agra in December, 1937, when they came out to India for the Jubilee session of the Indian Science Congress. In the year 1936-37 Sir John Russell, F.R.S., then Director, Rothamsted Experimental Station visited the Rust Research Laboratories at Agra and Simla officially and the writer had an opportunity of discussing at length the scope of these investigations with him. The writer wishes to express his sincere thanks to the above workers for the benefit of their opinion on different aspects of the rust problem.

The writer wishes to express his warmest thanks to the Imperial (now Indian) Council of Agricultural Research for the grants-in-aid sanctioned from time to time. The officers of the Council have always been very kind and accommodating and the writer wishes to express his sincere thanks to them.

Thanks of the writer are also due to the Governments of Nepal and the Dangs for permission to his assistants to study the incidence of rusts in their respective areas.

The kind help given by a large number of other workers as well as the loyal assistance rendered by the rust research staff are duly acknowledged in Part One.

Prof. F. T. Brooks, F.R.S. of the University of Cambridge kindly took the trouble of reading through the manuscript of this monograph and the writer wishes to express his warmest thanks for valuable suggestions made by him for greater clarification and abbreviation of several passages in the text. Thanks of the writer are also due to Dr C. W. B. Normand, Director General of Observatories, India, who read through portions of the manuscript dealing with meteorological aspects of the study and made some valuable suggestions.

The final manuscript of this monograph was sent to the Imperial (now Indian) Council of Agricultural Research in June, 1942 but owing to the acute shortage of paper it could not be published earlier.

Rust Research Laboratory,
Agra College, Agra
January 5, 1948

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Principal and Professor of Botany

SECTION IV. DISSEMINATION IN RELATION TO INITIAL OUTBREAKS

(With plates I & II and 123 maps)

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PART ONE

General

1. Introduction

IN India, wheat suffers from all the three rusts, i.e. black, brown and yellow, caused respectively by *Puccinia graminis tritici* (Pers.) Erikss. and Henn., *P. triticina* Erikss. and *P. glumarum* (Schm.) Erikss. and Henn. The black and yellow rusts are also found on barley.

There are nearly 35 million acres under wheat and another eight millions under barley in this country every year and the damage caused by rusts on these crops comes to nearly 60 million rupees annually. The bulk of the area under wheat lies in the Indo-Gangetic plain (the tract situated between the river Indus on the north-west and Bengal on the east). There is a considerable amount of wheat cultivation also in Peninsular India (situated roughly south of the line connecting Calcutta on the east with Baroda near the west coast).

Over the greater part of the country, wheat and barley are sown during October to November and harvested in March to April. In the hills, which cover nearly five per cent of the total acreage, these crops are generally sown about the same time but are harvested one to two months later, according to altitude. In some parts of Nepal, however, wheat and barley are sown rather early, i.e. in August to September, and at higher altitudes in the Nilgiris and Palni hills two crops are raised every year, one of which is sown during April to August and the other in September to November. The same applies to a small hilly area of Devikulum Taluq in the Travancore State.

A brief account of dissemination of rusts in relation to first outbreaks in the plains was published by the writer [Mehta, 1931, 1933]. Since then the scope of the study has been considerably enlarged with the object of collecting data from wind-trajectories for representative stations, in addition to the information obtained from the examination of stationary slides as well as those sent up on balloons and kites.

2. Relevant data and scope of the present investigation

A. Data from previous work in relation to the present study

In October, 1923, after an intensive search in the Kumaon Hills, the writer found heavy infection with brown rust on thousands of ratoon tillers from harvested plants and self-sown plants of wheat at Latibhunga, near Mukteswar, 7,500 ft. above sea level. Most of the self-sown plants were also found to be infected with yellow rust. In some of the fields wheat had been sown and others were being prepared for the purpose. Prior to that there was no record in literature regarding the occurrence of viable uredospores of wheat rusts at the time of sowing anywhere in India.

As there is no trace of rusts at that time of the year in the plains, inoculations were made at Agra with fresh material brought down from Latibhunga in order to make sure if the unsuitability of temperature was responsible for delay in the appearance of rusts, assuming that they were caused by a local source of infection. Seedlings of wheat were inoculated in a cage on October

23, 1923 separately with uredospores of brown and yellow rusts. Brown rust appeared on the eighth day but there was no infection with the latter. The average maximum and minimum temperatures of Agra during the period of the experiment were 90.4°F. and 64.3°F. respectively. The culture of brown rust was successfully maintained at Agra till April, 1924.

After a preliminary study of the incidence of rusts in the Kumaon Hills and the plains of the United Provinces, the writer [Mehta, 1925] observed that (i) on account of the intense heat of summer there is little likelihood of the survival of uredospores of yellow and brown rusts of wheat from the previous crop in the plains of India, (ii) there is no local source of infection at the time when wheat is sown in the plains, (iii) uredospores are able to survive during summer at various altitudes in the hills where climatic conditions are more favourable and (iv) rust outbreaks in the plains are probably caused by uredospores blown down to the plains from such altitudes in the hills.

On October 2, 1927 inoculations were made by the writer at Mukteswar on wheat seedlings carried there in rust-proof cases and then brought down to Agra. Brown rust appeared on the eighth day but again no infection took place with yellow rust. These experiments were repeated at Agra on October 6 with uredo-material brought down from Mukteswar and brown rust appeared after seven days but yellow rust did not. The average maximum and minimum temperatures of Agra during the period of this experiment were 90.5°F. and 67.3°F. respectively. The culture of brown rust was again successfully maintained at Agra till the following April.

The inoculations referred to above were made on Agra Local wheat which the writer had found to be very susceptible to all the three rusts. The failure of infection at Agra in the case of yellow rust was most probably due to the range of temperature being rather high at that time of the year. In a previous publication the writer [Mehta, 1923] has stated that yellow rust suffers more from warm weather than the other two and thrives only under cooler conditions.

The above experiments show that weather conditions at Agra were favourable, at any rate, for brown rust during the month of October in those two years and that if there was any local source of infection the rust in question should have appeared on the crop at the latest by the end of November, i.e. within four to five weeks from the time it was sown. As it is, the initial attack of this rust occurred at Agra as late as February 1, 1924 and February 18, 1928 respectively, i.e. 3 to 3½ months from the time of sowing.

In subsequent years inoculations were again made several times at Agra in a cage with uredo-material of all the three rusts obtained by post from the Rust Research Laboratory at Simla during October to November. Cultures of black and brown rusts were established as a result of inoculations made in the middle of October but with yellow rust no infection took place before the end of November.

It is clear, therefore, that but for the absence of a local source of infection from the previous crop black and brown rusts should appear at Agra on the new crop at the latest by the end of November and yellow rust a fortnight later. Normally, however, as shown in the Tables of Aeroscope-slides in Parts Two, Three and Four, none of these rusts breaks out at Agra before February.

The information supplied about Agra applies, in general, to most of the stations in the plains of northern and central India, as will be clear from the tables dealing with the study of Aeroscope-slides in different parts of this monograph.

The contention made by contemporary workers as well as the writer [Mehta, 1923] regarding the absence of infection in the seed has been further supported by recent experiments carried out at Agra For a period of five years several varieties of wheat were grown up to the adult stage in a double-muslin cage, sides as well as top, with a space of nearly one inch between the two layers. No rust appeared even on the most susceptible varieties. Similarly, seedlings of several varieties of wheat as well as older control plants of Agra Local (a very susceptible variety) grown for the study of physiologic races in rust-proof seedling houses at Agra and Simla from year to year have always been free from rust although there is plenty of it every year in the fields and plots in the laboratory areas not far away.

In India *Berberis* and *Thalictrum*, the alternate hosts of black rust of cereals and the brown rust of wheat respectively, are restricted to the hills and none of the three rusts under reference is able to survive the critical period, i.e. the intensely hot summer, on any cereal or a wild grass in the plains.

These facts fully explain the delay of two to three, sometimes even three to four months in the initial outbreaks of rusts year after year in the plains of India, in general.

In the year 1928, as early as January, the new crops of wheat and barley at Mukteswar and Bhimtal (7,500 ft. and 4,500 ft. above sea level, respectively) in the Kumaon Hills were found by the writer to be heavily infected with yellow rust whereas there was no trace of rusts at any of the stations in the plains on the way from Agra.

After a further study of the incidence of rusts in the Kumaon Hills and the neighbourhood of Simla, the writer [Mehta, 1929] recorded the occurrence of the uredostage of yellow and brown rusts on self-sown plants and ratoon tillers from harvested wheat at 6,000-7,000 ft. above sea level during the interval between the harvest and the next sowing. On the strength of a series of experiments conducted with Hearson's nine-compartment incubator, to find out the influence of high temperatures on the viability of uredospores of all the three rusts of wheat and on the basis of a study of the incidence of rusts in the Indo-Gangetic plain, the writer also concluded that it is impossible for these rusts to survive the heat of summer which follows the harvest over the greater part of the plains of India.

In later contributions, the writer [Mehta, 1933, 1940] has supplied detailed information regarding the survival of the uredostage of all the three rusts on 'out of season' wheat during summer in the hills and also about their outbreaks in those areas on new crops, sown at some places earlier than the normal period, long before any trace of infection in the plains. It has also been observed that, in general, rusts break out earlier at the foot-hills and plant for plant there is heavier infection at those localities than in the neighbouring plains and further that the periods of rust appearance at the foot-hills as well as in the plains in different parts of the country are not the same.

The rôle of *Berberis* and *Thalictrum* has been fully discussed by the writer [Mehta, 1940] in the previous monograph and as explained therein these alternate hosts play little part in the annual recurrence of black and brown rusts respectively in the plains of India. For yellow rust no alternate host has been discovered anywhere so far.

It may safely be concluded, therefore, that rust inoculum is re-introduced into the plains of India every year from some other source and that this source in all probability lies in the hills where all the three rusts are able to oversummer in the uredostage.

B. Scope of the present investigation

Klebahn [1904] suggested that fresh outbreaks of rusts in different parts of the world may be caused by spores being blown long distances by wind.

Stakman, Henry, Curran and Christopher [1923] recorded the presence of viable uredospores of *Puccinia graminis* in air at an elevation of 7,000 ft. in the Mississippi valley. These spores were caught along with those of several other fungi, pollen grains, glumes of grasses and even small insects in spore traps exposed on aeroplanes. Viable aecidiospores of *P. graminis* were also caught at an elevation of 1,000 ft. On the basis of preliminary experiments, these authors pointed out that spores may be carried long distances by the upper-air currents and if they retain their viability, as some of them quite probably do, an epidemic might occur in one locality as a result of the transit of spores from an infection centre in another distant locality.

While dealing with dissemination and geographic distribution of plant rusts, Arthur and his collaborators [1929] discussed the part played by different agencies including insects, other small animals, human beings and water streams, etc. These authors pointed out, however, that wind is obviously the most important agency in the spread of rust spores under natural conditions.

It may be stated at the outset that the scope of the present investigation was restricted to the part played by wind in the dissemination of wheat rusts in relation to their initial outbreaks at the foot-hills and in the plains. In view of the huge expanse of hills all along the north and north-west and the total lack of facilities for local observations or for exposure of slides, it was not possible to include the dissemination of rusts within those areas in this study.

As far as the writer is aware, the study of rust dissemination with the help of trajectories of winds at different heights for representative stations in relation to spore showers and dates of initial outbreaks has not been attempted in any other country so far. The scope of the present investigation will be clear from the following example:

Black rust appeared on wheat at Agra on February 24, 1937 although the crop was sown early in November, 1936. Wind-trajectories were prepared from the date one month prior to that of rust appearance up to the commencement of the incubation period, the maximum duration of which was reckoned to be a fortnight. These trajectories were carefully studied in order to see if there were any winds during that period of a fortnight or so coming to Agra from a station or stations on the way where black rust had appeared well in advance and to determine which of the winds, if any, was followed by a spore shower. Ordinarily, curves for one week prior to the commencement of the incubation period should suffice, but in view of the likely delay in the detection of first rust outbreaks at some of the stations trajectories were prepared for a longer period.

On these lines as many as 11,355 wind-trajectories have been studied, taking into account all the three rusts of wheat and the various representative stations included in the study from time to time, since the year 1932. This number includes mostly wind-trajectories for 1,640, 3,280, 4,920 and 6,560 ft. above sea level. For some of the stations of Peninsular India trajectories were prepared also for winds at 8,200 and 9,840 ft. for one or two years in order to obtain

additional information. In addition, data of observations on clouds at 9,840 and 13,120 ft. above sea level were utilized in connection with movements of some of the winds.

For every station under study, the relevancy of winds was scrutinized in relation to dates of appearance of the rust concerned at places of earlier attack, dates of local spore showers, if any, and those on which rust appeared on the crop. Full attention was also paid to negative data and details are supplied in a large number of tables in the text.

3. Methods of study

(i) Exposure of slides in spore traps

At the request of the writer, the Director General of Observatories kindly arranged early in 1930 for the despatch of telegraphic messages from Poona to the Agra Observatory on those days during the cold weather, before the usual period of rust appearance, when winds were blowing from the Himalayas to the plains of the United Provinces. On the receipt of such messages microscope slides smeared with a little vaseline were sent up in spore traps on big hydrogen balloons from the Agra Observatory. A notice promising reward was attached to each balloon for its recovery.

The mechanism of the spore trap used in these studies has been described by Chatterjee [1931]. By the courtesy of that author his article has been included as Appendix A to this monograph.

(ii) Exposure of slides in wooden paddles from aeroplanes

Preliminary tests were also made in 1931-32 by the exposure of slides in wooden paddles, kept closed in glass jars before and after the exposure, from aeroplanes by the courtesy of the Royal Air Force at Amballa and the Flying Club, Delhi. This method was adopted by Stakman, Henry, Curran and Christopher [1923] and also by Craigie and Greaney, as described by Güssow [1926]. A microscope slide smeared lightly with vaseline on the upper surface is fixed in a paddle and the paddle kept closed in a glass jar ready for exposure. The exposure is carried out by keeping the paddle stretched out for a specified period against the wind at any desired height during a flight.

Only one spore was caught at an elevation of 4,000 ft. at Amballa and at Delhi several spores of all the three rusts were caught during December 1931 to March 1932 at 1,500 to 2,000 ft. above ground before and after rust appearance. As stated above, this study could not be continued for want of satisfactory arrangements and also because no aeroplanes were available at Agra or any other station where frequent observations could be made on the outbreak of rusts.

However, in March 1940 slides were again exposed in paddles from an aeroplane at Delhi to catch spores at different heights up to 10,000 ft. above ground and the data obtained from the examination of these slides are supplied in Table I.

Photographs of the wooden paddle used in these studies and of a uredospore of black rust, caught at 5,000 ft. above ground at Delhi, which germinated when kept in a moist chamber, are shown in Plate I.

(*iii*) *Exposure of slides (cellophane strips) on kites and small balloons*

During 1930-32 more slides were exposed in spore traps on big hydrogen balloons, but as recorded in a later article [Mehta, 1933] for further study cellophane strips smeared with vaseline were used for catching spores from the air with the help of ordinary captive kites. This device had to be adopted because, in spore traps, slides could not be exposed for more than five minutes on an average and also because no arrangements could be made for the exposure of slides from day to day on aeroplanes at any station owing to exorbitant charges. Kite flights proved to be very satisfactory besides being inexpensive. Ordinarily, a kite was kept in the air for one to three hours at a stretch. In still air an ordinary toy-balloon filled with hydrogen was tied to the kite.

In addition to the kites, small paper drums covered with cellophane strips smeared with vaseline and tied to a light bamboo frame were sent up with two toy-balloons, also kept captive. After exposure the cellophane strips were fixed on microscope slides with the help of half-slide labels pasted downwards for examination under the microscope. These devices are illustrated in Plate II.

Data obtained from the study of slides exposed in spore traps, on kites and small balloons are given in Parts Two, Three and Four, dealing with the dissemination of black, brown and yellow rusts respectively.

(*iv*) *Exposure of stationary slides in aeroscopes*

This study was started in the year 1929-30. Since then the number of stations at which aeroscope-slides were exposed was increased from time to time as facilities became available. These stations are shown in Map No. 1. During the first two years a half-slide aeroscope, shown in Plate I and kindly designed for the writer by G. Chatterjee, the Meteorologist-in-charge Upper-Air Observatory, Agra, was used. This pattern was later on replaced by the full-slide aeroscope, also shown in Plate I, which has been in use since 1931. It was constructed after the sample kindly supplied to the writer by Dr Güssow in 1930, then Dominion Botanist, Canada. This aeroscope, or a weather-vane type of spore trap, as it is called, was originally designed by Dr P. M. Simmonds and has been used by Canadian workers in the study of rust dissemination. In order to safeguard against removal of the aeroscope from its stand without tools the open nut of this pattern was replaced by a circular screw fitted to the metallic tube below the box.

As stated above, the aeroscope is a weather-vane type of spore catcher. The box of the aeroscope has a sliding lid after the removal of which a microscope slide bearing the date of exposure and smeared with a thin layer of vaseline is inserted in the slot inside the box and the lid replaced. The aeroscope is fixed firmly to a wooden stand nearly 4 ft. above ground making sure that its box moves freely with the wind.

A copy of the printed instructions issued to all stations selected for the exposure of slides in aeroscopes is included as Appendix B. Ordinarily, slides were changed at each station twice a week as it was not possible to arrange for daily exposures without considerably cutting down the number of stations or engaging additional staff for the examination of slides. As it is, with the full number of stations nearly 2,000 slides had to be examined each year by the rust research staff.

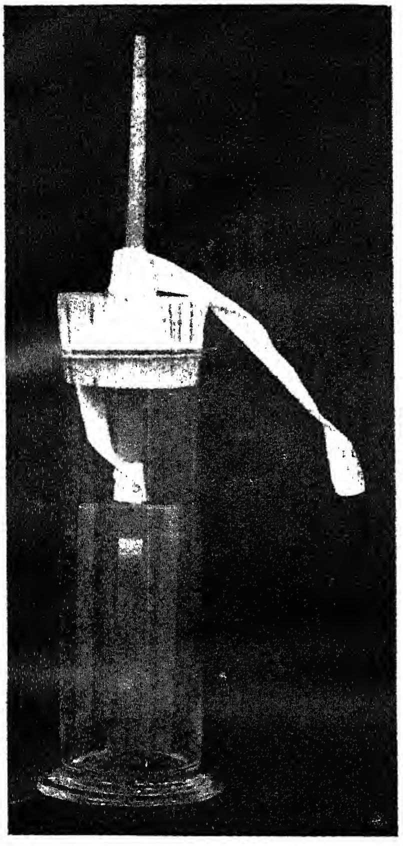


Fig. 1.

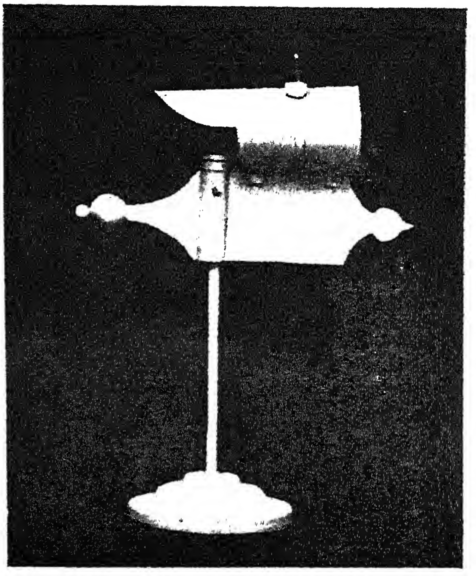


Fig. 3.

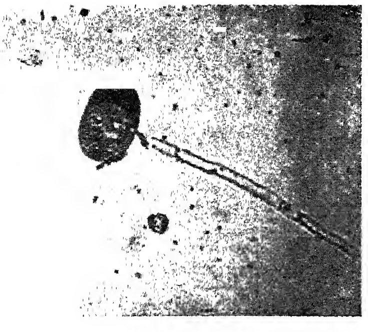


Fig. 2.

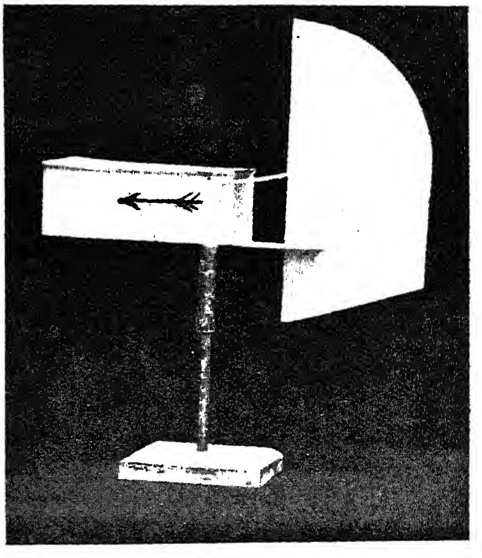


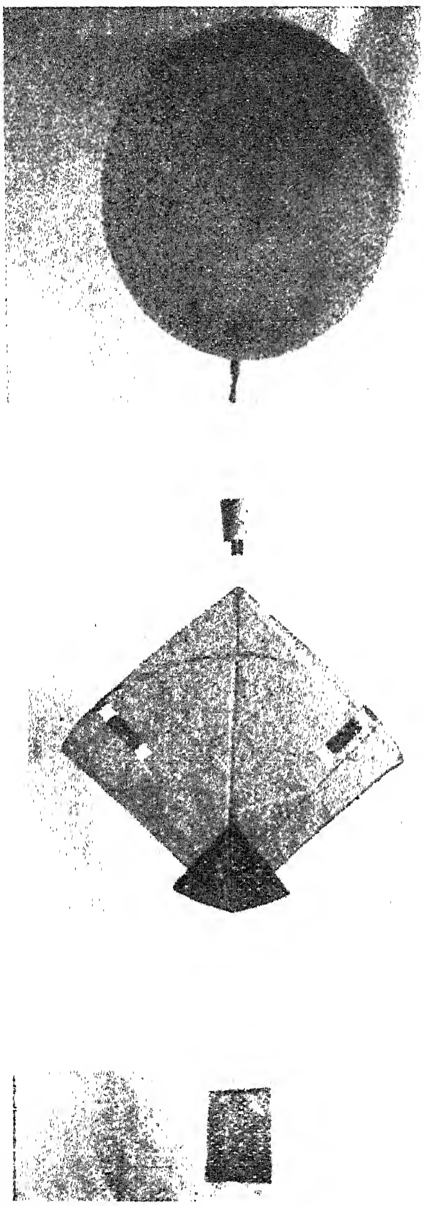
Fig. 4.

1. A wooden paddle for the exposure of a slide from an aeroplane closed in a glass jar. A paddle of this type was originally used by workers in U.S.A. and Canada, as explained in the text.

2. Micro-photograph of a germinating uredospore of black rust, caught on a slide exposed from an aeroplane near Delhi and kept in a moist chamber x App. 400.

3. Half-slide aeroscope, designed by G. Chatterjee, Meteorologist-in-charge, Upper-Air Observatory, Agra.

4. Full slide aeroscope or a weather-vane type of spore trap originally designed by P. M. Simmonds and used by the Canadian workers.



1. A kite in action, designed by the writer. Two cellophane strips smeared with a little vaseline are pasted on the kite, which is kept a captive. Photograph shows the flag which is intended for calculating the height up to which the kite flies.

2. A drum with cellophane strips tied to a bamboo frame sent up with a pair of toy balloons.

It is necessary to point out that even daily exposures would not have solved the difficulty of scrutiny of spore showers in relation to winds of different heights. For instance, if there are simultaneous winds any day at more heights than one or on two to three consecutive days, and that is likely to happen frequently, it is not possible to say definitely which of them actually brought the inoculum to the station concerned.

Slides received after exposure from all stations were examined after the addition of a few drops of liquid paraffin to clear the field under the microscope and also to separate spores that might have been sticking to dust particles.

In order to enable every observer to distinguish spores of rusts of wheat from others, a table showing the range of measurements and other characters of different rusts, including the black rust of oats and the rusts of *jowar* and *bajra*, i.e. *P. purpurea* (Cke.) and *P. penniseti* (Zimmerm.), was prepared at the commencement of these studies. As recorded in the previous monograph [Mehta, 1940], rye has been infected by two out of the six physiologic races of *P. graminis tritici* occurring in this country but so far *P. graminis secalis*, the black rust of rye, has not been met with and with the exception of a very small area in the Punjab Hills, rye is not cultivated at all. For the facility of comparison, in cases of doubt, slides were also prepared beforehand from fresh specimens of wheat rusts year after year.

(v) *Preparation and scrutiny of wind-trajectories*

It is necessary to point out that the printed instructions issued in connection with the exposure of aeroscope slides were not strictly followed at every station. In some cases the same slide was kept exposed for a week or more and occasionally slides were not exposed for several days at a stretch. At two stations the writer noticed that the board of the aeroscope was so inclined that the weather-vane could not move. At another the vaselined surface of the slide was kept in the wrong direction and sometimes slides were received to which no vaseline had been applied at all. The real difficulty arose with regard to dates of first appearance of rusts from some of the stations and also with the identification of rusts. For instance, samples of loose smut of wheat were supplied in place of black rust and collections labelled as brown rust turned out to be those of black on examination by the writer or a member of the rust research staff. Once even yellow rust was mistaken for brown. With regard to the accuracy of the dates of rust appearance, as communicated from some of the stations, the writer is in great doubt and it seems that frequent observations were not made on the crops at these places at all. Often the rust in question had appeared several days before the date of observation because the writer or a member of the rust research staff on tour, who happened to visit those stations on such dates, found well-advanced infection. With this difficulty in view, wind-trajectories were prepared some times for slightly longer periods, but it was not possible to do so when the information about rust appearance was received after several reminders and simply stated that the rust in question appeared in the second or third week of a particular month. Occasionally, the reply stated that observation was made on a certain date and probably the rust appeared on that very day. However, information regarding the dates of rust appearance received from the Provincial Stations of Agricultural Research and a few others should be reliable on the whole.

In general, wherever heavy infection (70 per cent or above) was observed locally by a member of the rust research staff within a week or so of the reported

date of rust appearance, the date of the initial outbreak at that station was put back by three to four weeks for the purpose of preparation of wind-trajectories. Similarly, an allowance of 10 to 15 days was made for cases of 20 to 50 per cent crop infection.

For a preliminary study of rust dissemination trajectories were prepared for winds at 1,640 ft. above ground for 29 stations on the basis of data obtained from the examination of aeroscope-slides and of dates of rust appearance during 1932-33. The names of those stations are:

Lyallpur, Gurdaspur, Hoshiarpur, Rawalpindi, Simla, Sakrand, Agra, Kanpore, Gorakhpur, Nawabgunj (Bareilly), Almora, Pusa, Patna, Sabour, Ajmer, Jubbulpore, Khandwa, Dharwar, Poona, Niphad, Arbhavi, Dohad, Baroda, Mehsana, Parbhani, Bangalore, Mysore, Chitaldroog and Coimbatore.

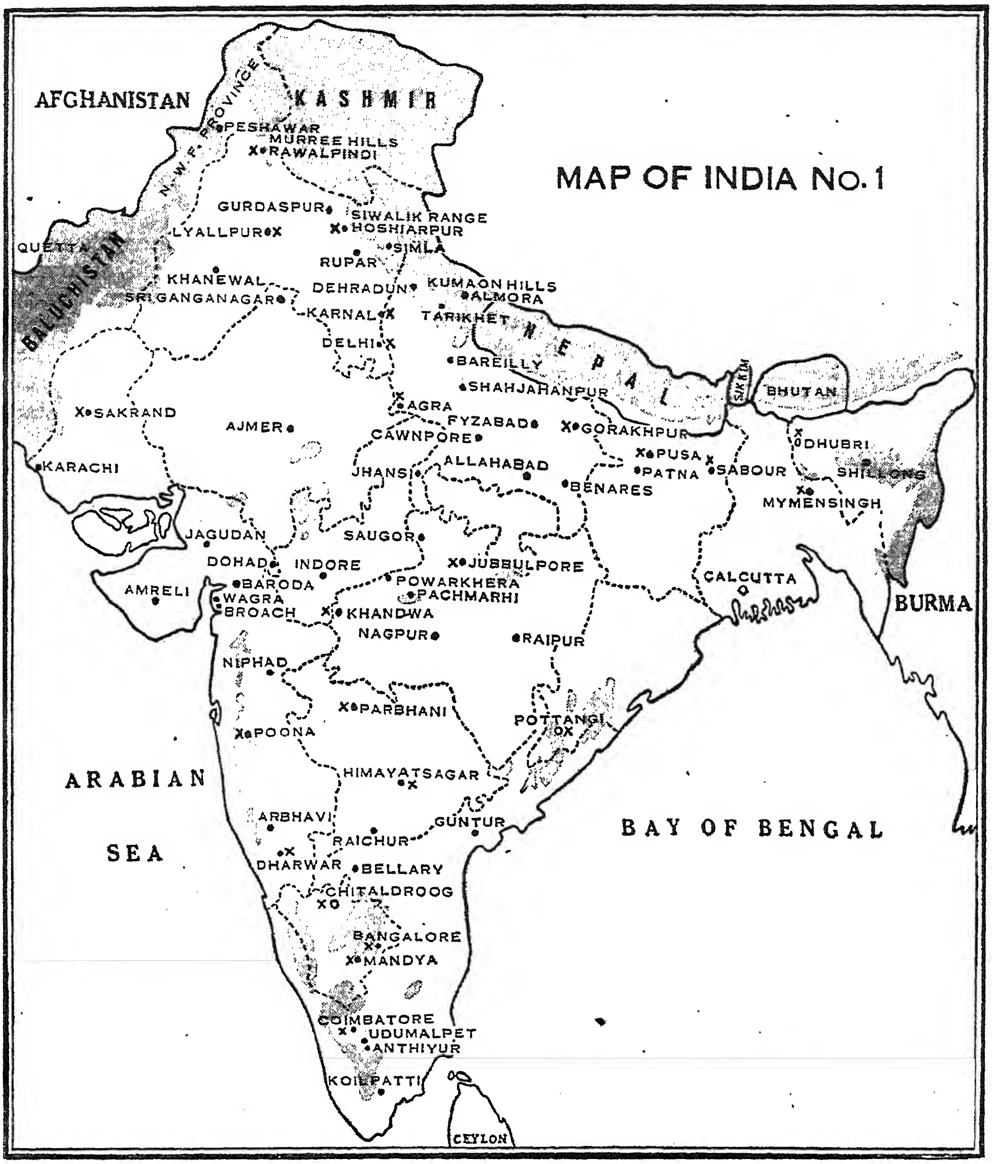
In view of the differences in the altitudes of the above stations it was decided to have wind-trajectories prepared only for standard heights above sea level. More trajectories were, therefore, prepared for six representative stations, Lyallpur, Hoshiarpur, Agra, Pusa, Sabour and Jubbulpore for winds at 1,640 ft. and 3,280 ft. above sea level for the study of dissemination of black rust. Fresh trajectories were also prepared for Lyallpur, Agra, Pusa and Sabour for brown and yellow rusts. For black rust trajectories for three more stations, Poona, Chitaldroog and Dharwar, each with an altitude of more than 1,640 ft., were added later for winds at 3,280 ft. above sea level. Whereas on scrutiny of the above trajectories several winds were found to have passed over a station or stations of earlier rust appearance, it was felt necessary to obtain data of winds at higher levels also for the sake of fuller information.

Fresh wind-trajectories for 1932-33 were, therefore, prepared on separate maps for six out of the nine stations mentioned above for winds at 1,640, 3,280, 4,920 and 6,560 ft. above sea level. For Poona, Dharwar and Chitaldroog trajectories were prepared only for the last three heights.

As stated above, in subsequent years trajectories were prepared only for standard heights above sea level. The maximum number of representative stations selected for any year, taking the three rusts together, was 20. Excepting once no trajectories were prepared in connection with a rust or rusts that did not appear or for which information could not be obtained from the station concerned. Stations for which wind-trajectories were prepared for standard heights during 1932-38 are shown in Map No. 1.

With regard to wind observations plotted on Working Charts of the Meteorological Office, Poona, it is important to note that up to the end of February, 1937, these charts generally gave information regarding morning winds only. With effect from March 1, 1937 afternoon charts based on observations made at 17 hours (Indian Standard Time), were also prepared regularly. A list of Pilot Balloon Observatories, the wind observations of which were utilized for drawing the wind-trajectories for this study, a list of stations for which trajectories were prepared and other information kindly supplied by the Superintending Meteorologist, Upper-Air Observatory, Agra, are given in Appendix C.

Data of all the wind-trajectories were tabulated, including dates of appearance of the rust concerned at the stations under study as well as information, if available, about the dates of rust outbreaks at places on the way and those wherefrom winds were traceable. On scrutiny, only such winds were regarded 'relevant' as had started from or passed over one or more stations where the rust in question had appeared at least 15 days earlier than the dates of the winds concerned. Ordinarily, the amount of inoculum after only 15 days from



Stations where slides were exposed in aeroscopes are marked ⊙

Stations for which wind-trajectories have been studied are marked ×

1B

the date of initial outbreak at any station should not be large enough for dissemination but this may happen in the event of simultaneous infection of a large number of plants, due to a heavy spore shower. Besides, in this country nearly 80 per cent area of wheat cultivation is covered by the highly susceptible indigenous (*dèsi*) varieties and the actual dates of rust appearance, as reported from some of the stations, might have been a week or two earlier. For these reasons, it was felt necessary to fix the minimum period for relevancy of winds at 15 days.

Similar procedure was followed regarding winds which were traceable from hill stations where the rust in question had repeatedly been found to oversummer or had been observed in an advanced stage, due to early sowings. Such winds were taken as 'possibly relevant' only for want of information about the actual dates of rust appearance in those areas. No arrangements could be made for the supply of information regarding dates of appearance of rusts from most of the hilly areas on account of the absence of local scientific staff.

Every 'relevant' and 'possibly relevant' wind-trajectory was further scrutinized in relation to spore showers, if any, at the stations under study and the date of appearance of the rust concerned, making allowance for the incubation period. In the scrutiny of all spore showers due attention was paid to the heights of winds concerned, keeping also in view the approximate time that spores would take in settling down to the ground level. This is fully explained under sub-head 10 (ii) of Part Two, with special reference to winds of each height.

All records of rust appearance at the stations under study, for which there were no 'relevant' winds but spore showers had occurred well before rust appearance, were also scrutinized in order to find out if those spore showers could be attributed to 'possibly relevant' winds, i.e. those which came from the hills. It is understood that where, after scrutiny, even 'possibly relevant' winds were not found spore showers must have been caused either by such winds from the hills as blew during the intervals between daily meteorological observations or those that had passed over stations of earlier outbreaks in the plains about which no information was available regarding the date of appearance of the rust concerned.

After careful tabulation of necessary data the information recorded in different columns was scrutinized by a person or persons other than the one who had made the various entries. The interpretation regarding the relevancy of each wind-trajectory was further checked by the writer himself.

It has already been recorded by the writer [Mehta, 1940] that owing to the presence of an early crop at higher altitudes in the Nilgiris and Palni Hills all the three rusts of wheat are found in plenty from August onwards and consequently there is enough inoculum in those areas during October when wheat is sown in the plains of Peninsular India. As there is no wheat cultivation in the plains of the southern part of Mysore State situated to the north of the Nilgiris, it was necessary to connect this area with the districts of Hasan and Chitaldroog by growing wheat in miniature plots at Mandya. Another miniature plot was arranged for at Bangalore. Sowings were made in these plots nearly two months ahead of the normal period so that if rusts appeared in them, prior to or at the time of normal sowings in other parts of Peninsular India, there may be no doubt regarding their dissemination from the Nilgiris and Palni Hills. A miniature plot was also started in 1937 at Coimbatore, situated at the foot of the Nilgiris on the south, and wheat was sown there once every month

from June to October. Arrangements for these plots were kindly made by the local authorities at the request of the writer who supplied seed of Agra local wheat, a variety that had been found by him to be very susceptible to each of the physiologic races of all the three rusts.

During the course of these studies no arrangements could be made for the survey of rusts in Afghanistan and Baluchistan nor could any information be obtained, except from Quetta, regarding the dates of rust appearance from either of those countries for want of local scientific staff. The same applies to Bhutan and Sikkim in the Himalayan range situated to the north of Bengal. These countries are not open to visitors without special permission of the governments concerned and considering the other difficulties travelling is not possible except for a party fully equipped.

Observations on the incidence of rusts were, however, made in Nepal with special permission given by its government to a member of the rust research staff for casual visits to specified parts of that country.

With regard to the interpretation of wind-trajectories the writer had frequent opportunities of consulting the Superintending Meteorologist of the Agra Observatory as well as the Agricultural Meteorologist at Poona.

Before writing up this monograph the writer also had the benefit of a scrutiny of wind-curves, selected at random, by a leading statistician of the Statistical Laboratory at Calcutta.

The remarks of the meteorologists and the statistician, referred to above, have been carefully considered and kept in view during the final scrutiny of data regarding 'relevant' and 'possibly relevant' winds as well as spore showers.

The writer [Mehta, 1939] gave an illustrated account of this study while opening a discussion on the Dissemination of Cereal Rusts in India before the Botany Section of the Jubilee Session of the Indian Science Congress 1938, details of which are supplied in various parts of this monograph.

It seems necessary to point out that in a country of the size of India and for want of local facilities for meteorological data at most of the stations fuller information for this study could be obtained only by the appointment of dozens of assistants who could be posted in different areas. In view of the auxiliary nature of the study of wind-trajectories, it was difficult for the writer to make out a case for so many appointments when work on the lines detailed above had not been attempted elsewhere, including Europe and North America. It will be clear, however, from Map No. 1 that the country was linked by a large number of representative stations where stationary slides were exposed and observations on the incidence of rusts were also made at several other places. It would, however, be incorrect to state that the information obtained regarding dates of rust appearance is the fullest possible for each of the large areas, much less for each district or locality. A good deal more could be done if facilities were also available in each Province or State for the exposure of slides at different heights on aeroplanes but this was not possible because of excessive cost and the absence of aeroplanes in most of them.

4. Acknowledgments

In the tabulation of data as well as scrutiny and interpretation of the relevancy of wind-trajectories Messrs. H. R. Bhargava, R. Prasada and D. D. Gupta rendered valuable assistance. The writer wishes to express his warmest appreciation of their labours.

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For a period of three years, i.e. from 1935 to 1938, Mr. J. C. Luthra, Professor of Botany, Agricultural College, Lyallpur, Dr. B. N. Uppal, Plant Pathologist to the Government of Bombay, and Mr. S. Sundararaman, Government Mycologist, Madras and later on Mr. K. M. Thomas, who succeeded him in that office, co-operated with the writer by their kind supervision of the survey of rusts in their respective provinces. The writer wishes to express his sincere thanks to these workers. In this study Mr. L. D. Galloway, then Imperial Mycologist, Imperial Agricultural Research Institute, Pusa, helped the writer by the loan of one of his fieldmen for survey at the foot of the Nepal range during 1935 to 1936 and thanks of the writer are also due to him. The writer also wishes to thank Messrs. Dayal Singh, Sikandar Lal Sahgal, B. S. Varadarajan, T. V. Pattabhiraman and C. B. Sahaya, who assisted in the survey of rusts in the different provinces.

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The Directors of Agriculture in the Punjab, Sind, United Provinces, Bihar, Orissa, Central Provinces, Bengal, Assam, Bombay-Deccan, Baroda, Hyderabad (Deccan), Madras and Mysore; Agricultural Officers in N.-W. F. Province and Baluchistan; the Directors of the Imperial (now Indian) Agricultural Research Institute, Pusa (now in New Delhi) and the Bureau of Plant Industry, Indore; the Professor of Botany, University of Allahabad, the Lecturer in Biology, Agricultural Institute, Allahabad, the Professor of Botany, Government College, Ajmer and the Lecturer in Biology, St. Andrew's College, Gorakhpur.

The writer also wishes to express his thanks to the Superintendents of Agricultural Farms in different Provinces and States who assisted in this study by exposing slides and reporting the dates of rust appearance on the local crops from year to year.

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TABLE I

Study of slides exposed on Aeroplanes at Delhi

Serial number	Date of exposure	Height reached in feet above Delhi*	Period of exposure in minutes	Spores caught		
				Black rust	Brown rust	Yellow rust
	1931-32					
1	December 23 ...	2,000	15	1	5	0
2	January 6 ...	2,000	15	0	0	0
3	February 4 ...	2,000	15	1	1	0
4	February 9 ...	1,500	15	0	0	0
5	February 24 ...	2,000	15	0	0	0
6	March 3 ...	1,500	15	4	0	26
7	March 7 ...	1,500	15	6	3	15
8	March 17 ...	2,000	15	0	1	0
	1939-40					
1	March 13 ...	1,500—5,000	5	0	2	0
2	,, ...	5,000	15	3	5	3
3	,, ...	5,000—10,000	17	2	0	1
4	,, ...	10,000	15	6	0	1
5	,, ...	10,000—5,000	8	2	0	0
6	,, ...	5,000—1,500	5	0	2	0
7	,, ...	1,500—ground	2	0	0	0

* The aerodrome at Delhi is 700 ft. above sea level

PART TWO

Dissemination of *Puccinia graminis* Pers.

6. Review of literature

Reference has already been made to preliminary experiments carried out by Stakman and others [1923] for catching spores of *Puccinia graminis*, the black stem-rust, from the upper-air in the United States.

Güssow [1926] gave an account of spore trapping experiments with aeroplanes as well as of the study of stationary slides exposed in the weather-vane type of spore traps at several stations in Canada; he arrived at the following conclusion :

'Almost in proportion as the station is situated further west or north, the amount of inoculum is gradually diminished and the date of the arrival of rust is 'retarded'. This work suggests that the source of infection with black rust is blown by southerly winds from the United States to Canada, where there is no overwintering of uredospores of black stem-rust.

Bailey and Craigie [1926] stated that spores of *P. graminis* are carried by wind for considerable distances from their place of origin.

Craigie [1926] observed that the initial rust infections in Manitoba each year are caused by wind-borne spores from the south.

Roussakov [1926] remarked that in the Amur region (U. S. S. R.) spring infection of the local wheat crop with black rust is probably caused by spores brought from distant places by air currents.

Shitikova-Roussakova [1927] gave a similar explanation of the spread of *P. graminis* by uredospores from North Manchuria, where it is able to overwinter, to the Amur region of the U. S. S. R.

Similarly, Stakman [1927] pointed out the possibility of the infection of cereals by uredospores of stem-rust blown by southerly winds to the north of the United States, where this rust cannot overwinter in the uredostage. Stakman, Kempton and Hutton [1927] also referred to the spread of black rust from the south, where it is able to overwinter in the uredostage, to the barberry-eradication area in the north of the United States.

In Manitoba, as reported by Güssow [1928], a critical examination of the air above wheat fields was carried out with spore traps for a period of three years and the data obtained were significant in so far as spores were caught, each year before any rust was found locally. This author observed further that the time at which spores were trapped bore a definite relationship to the stage of rust development further south and concluded that infections with stem-rust in the Western Canada were caused each year by wind-borne spores from farther south.

In the following year, Popp and Craigie [1929] reported heavy spore showers over Manitoba two weeks before the local outbreak of stem-rust and they observed that the West-Central States of the United States were the probable source of that inoculum. The number of spores caught at Winnipeg two weeks before rust appearance, as recorded by these authors, was 266 on one stationary slide.

The writer [Mehta, 1929] stated that in India the source of annual outbreaks of black rust lies in the hills.

Lambert [1929] observed that there is circumstantial evidence of rust being blown several hundred miles from a severely infected area and that southerly winds have been known to sweep u the Mississippi valley, at the time when stem-rust is most plentiful in the south, with sufficient velocity to carry spores from Texas to the spring wheat area in less than three days.

Reference may here be made to chapter V of Plant Rusts by Arthur and his collaborators [1929].

Later on, Peturson [1930] recorded the outbreak of stem-rust at Manitoba 20 days after the date on which spores were caught on a stationary slide. This author also remarked that there were no definite spore showers in the summer of 1930 but a light sprinkling of spores was gradually coming from the south.

Stakman [1931] stated that enormous number of rust spores are carried into the upper-air currents and may be disseminated over wide areas and that under certain conditions uredospores may be blown from southern Texas into the Dakotas and Minnesota, a distance of nearly 1,100 miles, in 48 hours. From the studies carried out in the United States, this author concluded that in some years uredospores are blown from the south to the north early enough in the season to cause rust epidemics from this source alone.

The writer [Mehta, 1931; 1, 2] after nearly seven years' study of the incidence of rusts in plains as well as the hills of India reported that the few viable uredospores occurring at harvest time in the plains are killed during the intensely hot summer (May to June) that follows. Consequently, there is no local source of infection in the plains when the new crops are sown. Further, that rust outbreaks are probably caused in the plains annually by wind-borne infection starting from the hills, where each of the three rusts of wheat had been found to oversummer in the uredostage. It was also recorded that uredospores of black rust were caught at Agra on a balloon as well as on a stationary slide well before the appearance of that rust in 1930.

Shitikova-Roussakova (1932) again stressed the importance of the study of wind currents in connection with the spread of cereal rusts. Her observations on the distribution of rust spores in the atmosphere were based on seven years' study in different parts of the U. S. S. R. and refer particularly to those areas where the rôle of intermediate hosts is of secondary importance and where winter crops of cereals are not available for the hibernation of the rust fungi.

Stakman, Hines, Ukkelberg and Butler [1932] stated that the data from spore trap exposures and observations on the northward spread of rust during 1929-31 indicated that uredospores of five forms (physiologic races) common during spring in Texas were carried northwards by high winds from that area, where some of them had apparently overwintered in the uredostage.

Ukkelberg [1933] studied the rate of fall of uredospores of four cereal rusts and found the differences to be statistically significant. In the case of black stem-rust of wheat the average rate of fall in still air was recorded by this author to be 11.57 ± 0.03 mm. per second and he also observed that the clusters of spores fall at a higher rate, as one would expect. This author also stated that the average theoretical dispersal distance of uredospores of black rust of wheat from an altitude of 5,000 ft. and carried by a 30-mile wind was found to be 1,100 miles.

Scheibe [1933] suggested that the dissemination of black rust of wheat takes place by strong winds from the south or south-east to the Balkans from unknown centres of overwintering.

On the basis of three years' study of rust dissemination, the writer [Mehta, 1933] observed that spores of black rust were caught at several stations, well before its appearance on the local wheat crop.

Stakman [1934] again observed that black stem-rust usually survives the mild winter of southern Texas in the uredostage and also referred to the inoculum being blown from Mexico. He stated that uredospores may be carried by wind from Mexico and Texas, as shown by the results of spore trapping and other observations. Reference was also made by him to large numbers of spores being caught at the level of growing plants in southern Minnesota, and in one case as many as 800 spores were recorded per square foot during a strong southerly wind in advance of local rust development. He concluded, therefore, that the efficacy of wind as an agent of long-distance dissemination was established.

Brooks [1935] while reviewing recent work on epidemiology of rusts summarized the contributions from Australia, Kenya Colony, the United States, Canada as well as the writer's observations with regard to the foci in India, which need not be repeated here.

Again in his report on stem-rust for the year 1935 and summary report of rust epidemiology studies in 1937-38, both not yet published, Stakman stated that the red or summer stage (uredostage) of stem-rust overwinters nearly every year in southern Texas and occasionally in northern Texas as well and that barberry-eradication will not entirely eliminate rust because of spores being blown from Texas or surrounding States. With regard to the epidemic of 1937 this author stated that most likely the source was southern Mexico.

While discussing the epidemiology and dissemination of black rust Lehmann, Kummer and Dannenmann [1937] have summarized the contributions of several workers from other parts of the world up to that year and it is unnecessary, therefore, to repeat them here.

Savulescu [1938] observed that in Rumania, the principal source of infection with all the three rusts are the air-borne uredospores from the surrounding wheat-growing countries and that observations had established a direct relationship between the direction of the prevailing winds during the critical period for infection and the severity of rust outbreaks in different years.

The writer [Mehta, 1939] stated that although it was not possible to explain the source of rust outbreaks for the whole of India, two important foci had been located wherefrom rusts spread to the plains rather early in the season year after year.

Buller [1939] remarked that in western Canada there are no barberry bushes and yet wheat is attacked every year by *P. graminis*. According to him the source of infection consists of clouds of uredospores which are carried by winds for hundreds of miles from the middle western parts of the United States.

Craigie [1939] stated that south winds blow the spores directly into Manitoba and the heavier the infection in the upper Mississippi valley the greater are the chances of many spores being blown into Manitoba and of heavy infection occurring in that Province. Again, while referring to the sources of black stem-rust in North America, Craigie [1940] pointed out that overwintering of this rust in the uredostage is not known definitely to occur in Canada or the northern United States and that the most important overwintering area is the

state of Texas. Overwintering in the uredostage in Mexico also has been referred to by this author. Further, he has stated that strong winds passing over a large rust-infected area pick up and carry along enormous numbers of spores thus causing at rather distant points the so-called spore showers. Such showers, for example, in western Canada occur after a day or two of strong south winds.

Recently, Stakman, Popham and Cassell [1940] observed that as shown by the study of spores in the air and subsequent development of black-stem rust there is sometimes a seasonal interchange of rust between the United States and northern Mexico.

7. Study of rust dissemination with the help of aeroscope-slides

For this study stationary slides were exposed in aeroscopes at four stations in 1929 to 1930 and this number was added to from time to time as facilities became available. Exposure of slides had to be suspended or stopped at some of the stations either because arrangements for their continuity could not be made or due to the selection of a more suitable station in the same area. Slides were exposed at 62 representative stations but the maximum number in any year did not exceed 54. These stations are shown in Map No. 1.

It may be mentioned that in addition to the uredospores of one or more rusts of wheat; pollen grains, spores of smuts, *Alternaria, Puccinia penniseti, P. graminis avenae* and *P. purpurea* were caught occasionally. The last three were found only on slides exposed at some of the stations in the south. None of the slides examined so far has shown aecidiospores although teleutospores were caught on some.

For the sake of convenience of reference and in order to avoid presentation of data in crowded Tables, information relating to spore showers and the dates of appearance of each of the three rusts is given in separate parts of this monograph.

Full information regarding spore showers and dates of appearance of black rust is given in Tables II and III.

8. Study of balloon and kite-slides

Spore catching experiments with the help of balloons and kites were carried out only at the Agra Observatory and the data obtained from this study are given in Table IV.

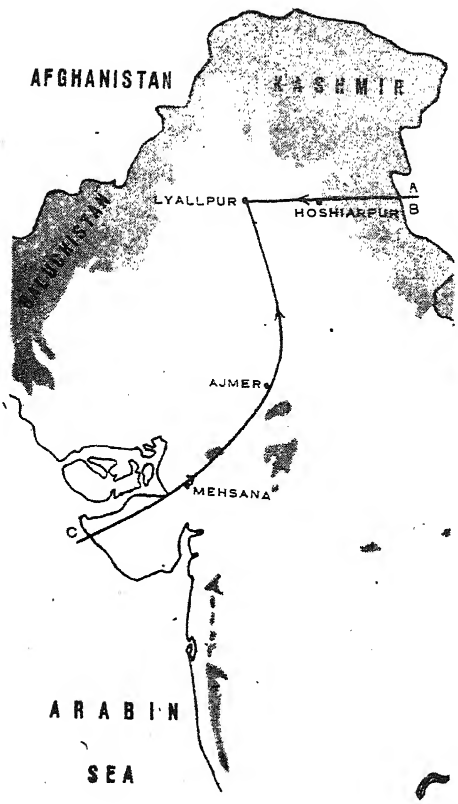
9. Study of dissemination with the help of wind-trajectories

During 1932 to 1938, 4,966 wind-trajectories were studied in connection with the dissemination of black rust to representative stations. As stated in Part One, the relevancy of these winds was carefully scrutinized in relation to spore showers and the dates of rust appearance at these stations.

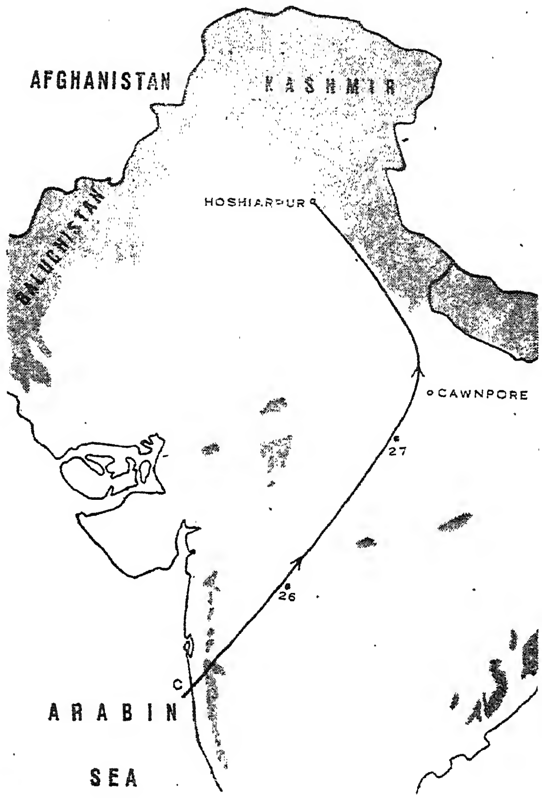
In order to economize space as well as to avoid repetition of illustrations only representative wind-trajectories have been reproduced on Map Nos. 2-46. Full details regarding these wind-trajectories, dates of spore showers, if any, and dates of rust appearance are supplied as foot-notes to the maps.

Data given in Map Nos. 2-46 have been summarized in Table V, wherein dates of spore showers, if any 14 to 10 days or so before rust appearance have also been recorded.

MAP NO. 2



MAP NO. 3



2. **LYALLPUR** (605 ft. above sea level). **BLACK RUST. ORIGINAL MAP No. 33.**

Date and heights of trajectories in feet ... April 4, 1933 : A—1640, B—3280, C—4920.

Dates of spore shower ... ... Slides were not exposed after April 4.

Date of rust appearance ... ... April 20, 1933.

A & B—The winds were traceable from Siwalik range and passed over Hoshiarpur where black rust had appeared by the middle of March 1933.

C—The wind entered the country on April 1 and passed over Mehsana and Ajmer on April 2 where black rust had appeared in the first week of February and on March 11 respectively.

3. **HOSHIARPUR** (702 ft. above sea level) **BLACK RUST. ORIGINAL MAP No. 919.**

Date and height of trajectory in feet ... January 28, 1935. C—4920.

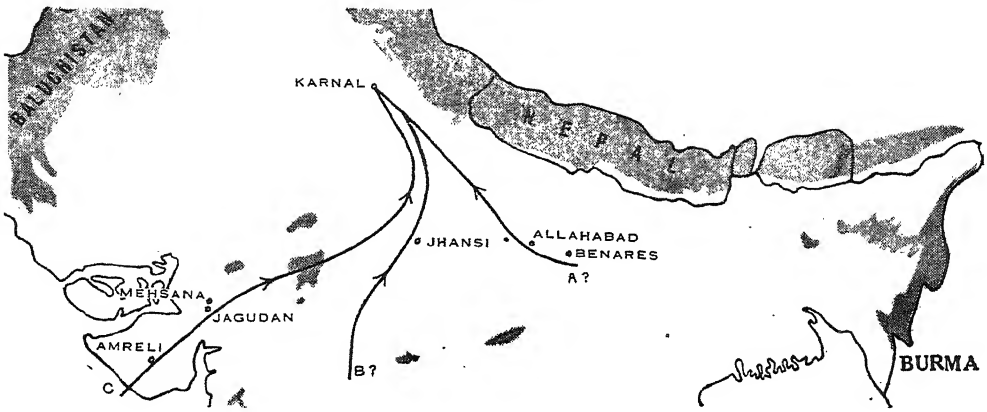
Dates of spore showers soon after the wind ... January 29—February 1 & February 1—4.

Dates of spore shower 14—10 days before rust appearance ... ... February 1—4.

Date of rust appearance ... ... First half of February 1935.

C—The wind entered the country on January 25 and passed near Cawnpore on January 27 where black rust had appeared in the X'mas week of 1934.

MAP NO. 4



MAP NO. 5

4. KARNAL (900 ft. above sea level). BLACK RUST. ORIGINAL MAP No. 1,589.

Date and heights of trajectories in feet ...	February 26, 1937 : A—1640, B—3280, C—4920.
Dates of spore showers	February 25—March 1** & March 1—4.
Dates of spore shower 14—10 days before rust appearance	March 1—4.
Date of rust appearance	March 12, 1937.

A—The wind was traceable from Bihar border, passed near Benares where up to 10 per cent crop infection was found on February 18—19 and near Allahabad where black rust had appeared on February 2.

B—The wind was traceable from C.P. and passed near Jhansi where up to 40 per cent crop infection was observed on February 21.

C—The wind entered Gujrat, passed near Amreli and Jagudan where black rust had appeared on December 20, 1936 and January 29, 1937 respectively and near Mehsana where up to 100 per cent crop infection was observed on February 6, 1937.

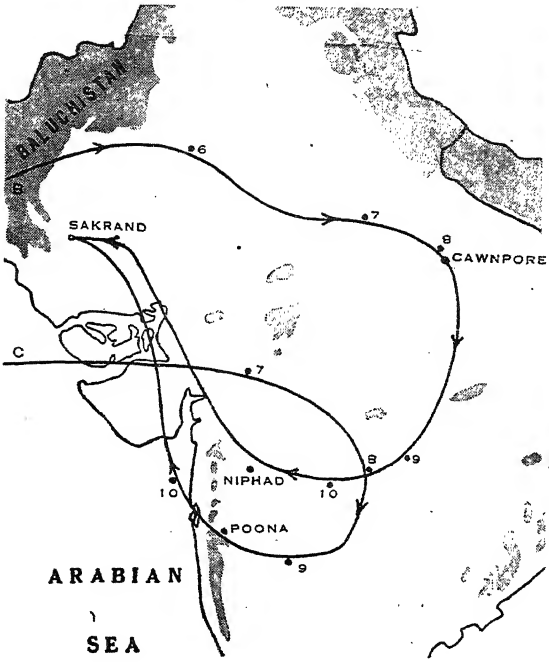
** The spore shower might have occurred on February 25, due to some earlier wind.

5. SAKRAND (120 ft. above sea level). BLACK RUST. ORIGINAL MAP No. 1,601

Date and height of trajectory in feet ...	February 23, 1937 : A—1640.
Dates of spore shower soon after the wind ...	February 25—28.
Dates of spore showers 14—10 days before rust appearance	February 28—March 1 & March 1—4.
Date of rust appearance	March 13, 1937.

A—The wind was traceable from the foot-hills of Nepal on February 21, 1937 and in central Nepal nearly 30 per cent crop infection with black rust was observed on December 6, 1936.

MAP NO. 6



MAP NO. 7

6. SAKRAND (120 ft. above sea level). BLACK RUST. ORIGINAL MAP Nos. 778 & 779.

Date and heights of trajectories in feet ...	February 11, 1935 : B—3280, C—4920.
Dates of spore shower soon after the winds ...	No spores were caught.
Dates of spore shower 14—10 days before rust appearance	February 21—24.
Date of rust appearance	March 4, 1935 (on March 7, 5—20 per cent crop infection was observed).

B—The wind was traceable from Baluchistan and passed over Cawnpore on February 8 and near Niphad on February 10 where black rust had appeared in X'man week of 1934 and on January 27, 1935 respectively.

C—The wind entered the country on February 6 and passed over Poona on February 9 where black rust had appeared in the second week of January 1935.

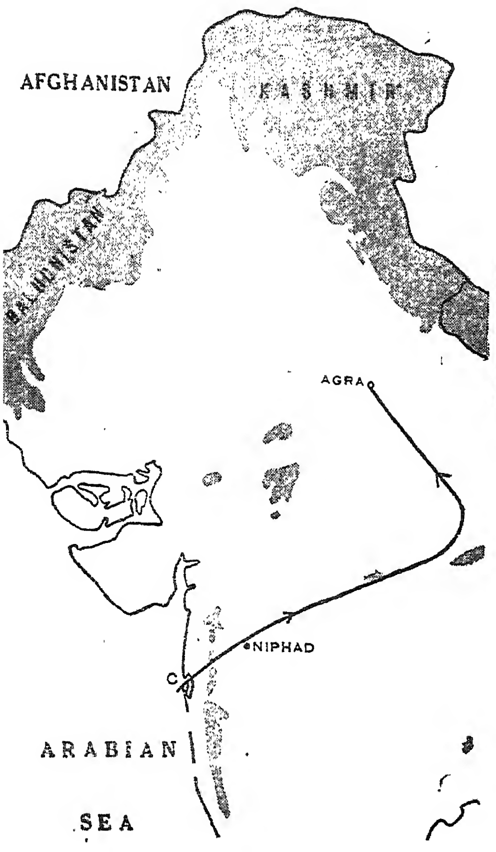
7. AGRA (554 ft. above sea level). BLACK RUST. ORIGINAL MAP No. 1,635.

Date and heights of trajectories in feet ...	February 5, 1937 : A—1640, B—3280.
Dates of spore showers soon after the winds ...	February 6—9 & 9—12.
Dates of spore shower 14—10 days before rust appearance	February 9—12.
Date of rust appearance	February 24, 1937.

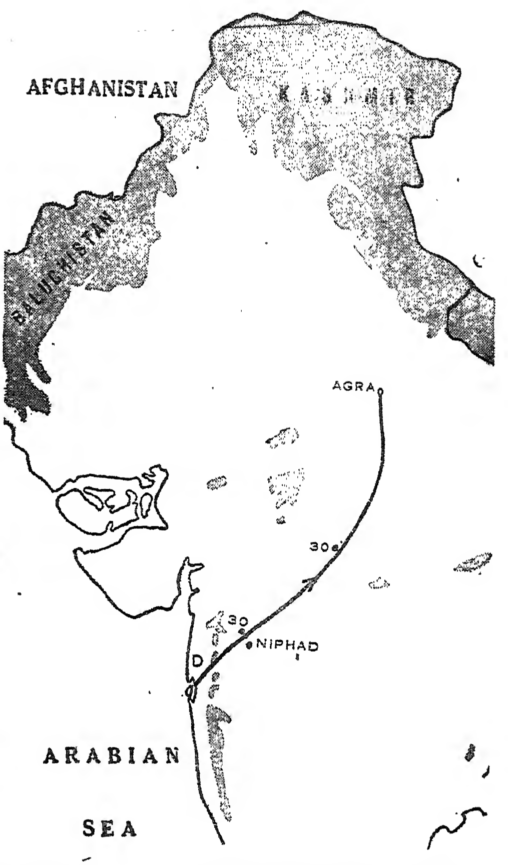
A—The wind was traceable from eastern Nepal and passed near Gorakhpur where black rust was observed in traces on January 5—6, 1937 and near Fyzabad where the rust had appeared in the 4th week of December, 1936.

B—The wind was traceable from central Nepal hills where nearly 30 per cent crop infection with black rust was observed on December 6, 1936.

MAP NO. 8



MAP NO. 9



8. AGRA (554 ft. above sea level). BLACK RUST. ORIGINAL MAP No. 1,636.

Date and height of trajectory in feet ...	February 6, 1937 : C—4020.
Dates of spore showers soon after the wind ...	February 6—9 & 9—12.
Dates of spore shower 14—10 days before rust appearance	February 9—12.
Date of rust appearance	February 24, 1937.

C—The wind entered the country on February 5 and passod over Niphad where black rust had appeared on December 3, 1936.

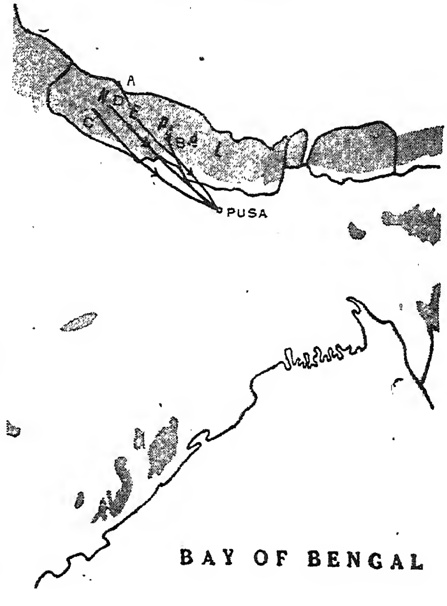
9. AGRA (554 ft. above sea level). BLACK RUST. ORIGINAL MAP No. 2,175.

Date and height of trajectory in feet ...	January 31, 1938 : D—6500.
Dates of spore shower soon after the wind ...	No spores were caught.
Date of rust appearance	February 19, 1938.

D—The wind entered the country on January 29 and passed near Niphad on January 30 where black rust had appeared on January 2.

MAP NOS. 10 to 13

MAP NO. 14



BLACK RUST.

10 to 13. GORAKHPUR (257 ft. above sea level). ORIGINAL MAP Nos. 1,657—1,660.

Dates and heights of trajectories in feet ...	December 13, 14, 15 & 16, 1936 : D—6560, A—1640, C—4920, B—3280.
Dates of spore shower soon after winds ...	December 17—20.
Dates of spore shower 14—10 days before rust appearance	December 23—26.
Date of rust appearance	No information (Traces on January 5—6, 1937).

A, B, C & D—The winds were traceable from central Nepal where nearly 30 per cent crop infection with black rust was observed on December 6, 1936.

14. PUSA (188 ft. above sea level). BLACK RUST. ORIGINAL MAP Nos. 832, 833, 834 & 835.

Date and heights of trajectories in feet ...	January 7, 1935 : A—1640, B—3280, C—4920, D—6560.
Dates of spore showers soon after the winds ...	January 7—10 & 10—14.
Dates of spore shower 14—10 days before rust appearance	January 21—24.
Date of rust appearance	January 31, 1935.

A, B, C & D—The winds were coming through central Nepal where 10—20 per cent crop infection with black rust was observed at different places on December 23, 1934.

MAP NO. 15

MAP NO. 16

15. PUSA (188 ft. above sea level). BLACK RUST. ORIGINAL MAP No. 1,702.

Date and heights of trajectories in feet ... January 23, 1937 : A—1640, B—3280, C—4920, D—6560.

Dates of spore showers ... ... January 22—26, ** 26—29.

Dates of spore shower 14—10 days before rust appearance ... ... January 29—February 2.

Date of rust appearance ... ... February 11, 1937.

A & C—The winds were traceable from western Nepal and passed near Gorakhpur where black rust was observed in traces on January 5—6, 1937.

B & D—The winds were traceable from Simla hills and passed over Gorakhpur where black rust was observed in traces on January 5—6, 1937.

** The spore shower might have occurred on January 22, due to some earlier wind.

16. SABOUR (122 ft. above sea level). BLACK RUST. ORIGINAL MAP No. 156.

Date and height of trajectory in feet above sea level ... ... February 15, 1933 : A—1640.

Dates of spore shower soon after the wind ... February 16—19.

Dates of spore shower 14—10 days before rust appearance ... ... February 16—19.

Date of rust appearance ... ... March 1st week, 1933.

A—The wind was traceable from central Nepal and passed over Gorakhpur where black rust had appeared on January 10, 1933.

MAP NO. 17

MAP NO. 18

17. SABOUR (122 ft. above sea level). BLACK RUST. ORIGINAL MAP Nos. 784 & 785.

Date and heights of trajectories in feet ...	February 14, 1935 : B—3280, C—4920, D—6560.
Dates of spore showers soon after the winds ...	February 14—18 & 18—21.
Dates of spore shower 14—10 days before rust appearance	February 25—28.
Date of rust appearance	March 8, 1935.

B—The wind passed through central Nepal where 10—20 per cent crop infection with black rust was observed at different places on December 23, 1934 and near Gonda, Gorakhpur and Patna where this rust had appeared on January 27, 28 and in the 4th week of January 1935 respectively.

C—The wind was traceable from central Nepal where 10—20 per cent crop infection with black rust was observed at different places on December 23, 1934 and passed near Gonda where it had appeared on January 27, 1935.

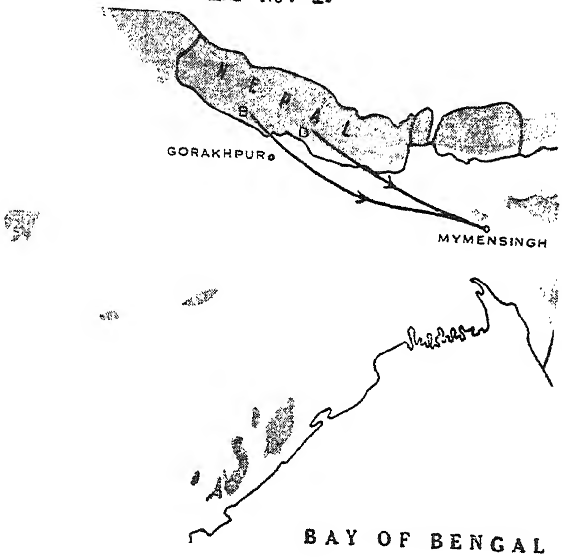
D—The wind was traceable from central Nepal where 10—20 per cent crop infection with black rust was observed on December 23, 1934.

18. MYMENSINGH (62 ft. above sea level). BLACK RUST. ORIGINAL MAP No. 1,757.

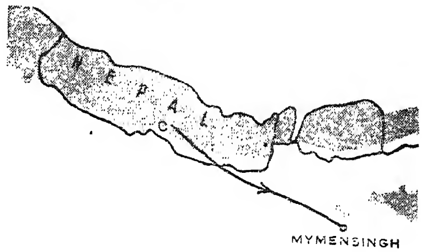
Date and height of trajectory in feet ...	January 8, 1937 : A—1640.
Dates of spore shower	Slides were not exposed.
Date of rust appearance	Did not appear (On February 15 traces to 3 per cent crop infection was observed in this district).

A—The wind was traceable from central Nepal where nearly 30 per cent crop infection with black rust was observed on December 6, 1936.

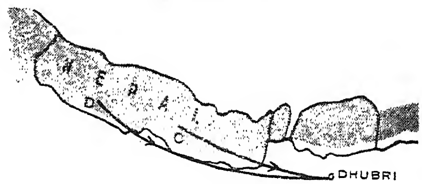
MAP NO. 19



MAP NO. 20



MAP NO. 21



19. MYMENSINGH (62 ft. above sea level). BLACK RUST. ORIGINAL MAP No. 1,769.

Date and heights of trajectories in feet ... January 20, 1927 : B—3280,
D—6560.

Dates of spore shower ... ... Slides were not exposed.

Date of rust appearance ... ... Did not appear (On February 15 traces to 3 per cent crop infection was observed in this district).

B—The wind was traceable from central Nepal, where nearly 30 per cent crop infection with black rust was observed on December 6, 1936, and passed near Gorakhpur where this rust was observed in traces on January 5—6, 1937.

D—The wind was traceable from central Nepal where nearly 30 per cent crop infection with black rust was observed on December 6, 1936.

20. MYMENSINGH (62 ft. above sea level). BLACK RUST. ORIGINAL MAP No. 1,768.

Date and height of trajectory in feet ... January 19, 1937 : C—4920.

Dates of spore shower ... ... Slides were not exposed.

Date of rust appearance ... ... Did not appear (On February 15, traces to 3 per cent crop infection was observed in this district).

C—The wind was traceable from central Nepal where nearly 30 per cent crop infection with black rust was observed on December 6, 1936.

21. DHUBRI (115 ft. above sea level). BLACK RUST. ORIGINAL MAP No. 1,784.

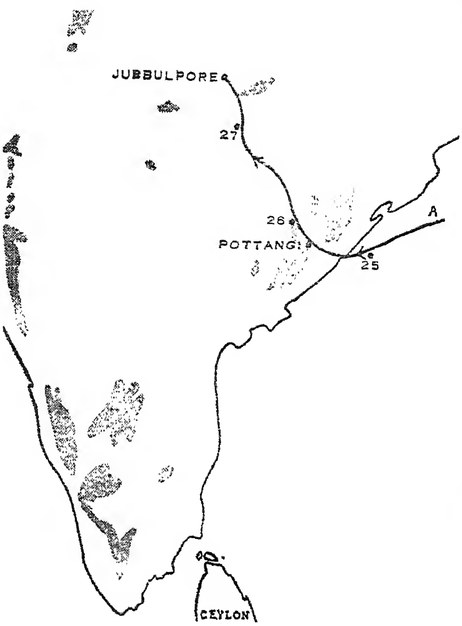
Date and heights of trajectories in feet ... December 16, 1936 : C—4920,
D—6560.

Dates of spore shower ... ... Slides were not exposed.

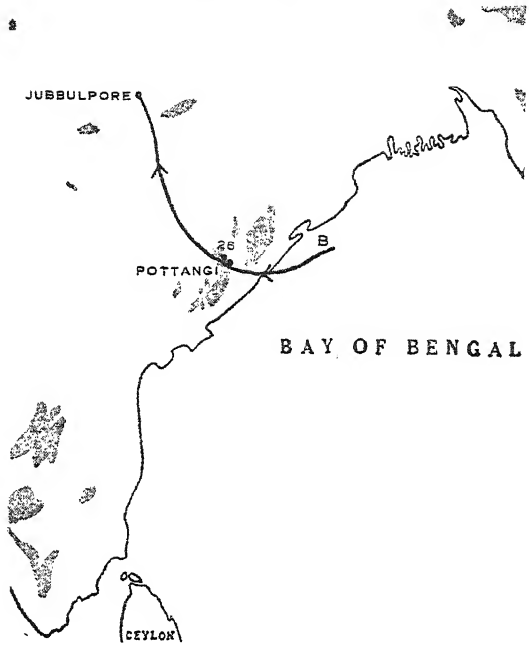
Date of rust appearance ... ... No information (On January 23, 1 to 25 per cent crop infection was observed.)

C & D—The winds were traceable from central Nepal where nearly 30 per cent crop infection with black rust was observed on December 6, 1936.

MAP NO. 22



MAP NO. 23



22. JUBBULPORE (1,289 ft. above sea level). **BLACK RUST.** ORIGINAL MAP No. 917.

Date and height of trajectory in feet ... **January 28, 1935 : A—1640.**

Dates of spore showers ... ... **January 27—31** & January 31—February 3.**

Dates of spore showers 14—10 days before rust appearance ... ... **January 31—February 3 & February 3—7.**

Date of rust appearance ... ... **February 17, 1935.**

A—The wind entered the country on January 25 and passed over Pottangi the same day where 1 per cent crop infection with black rust was observed on January 8—9, 1935.

**The spore shower might have occurred on January 27, due to some earlier wind.

23. JUBBULPORE (1,289 ft. above sea level). **BLACK RUST.** ORIGINAL MAP No. 914.

Date and height of trajectory in feet ... **January 27, 1935 : B—3280.**

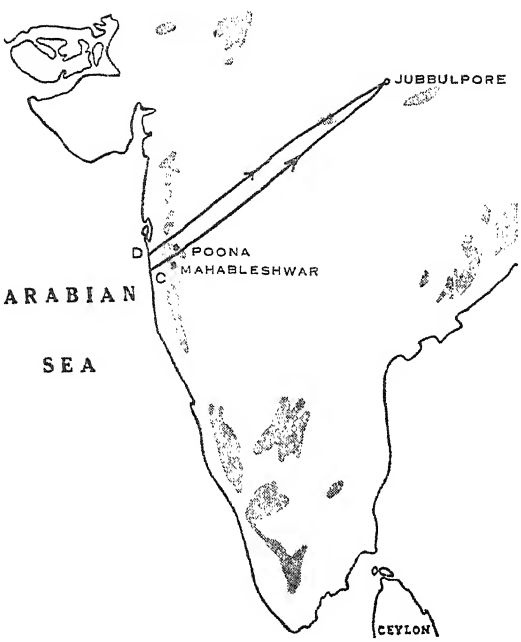
Dates of spore showers soon after the wind ... **January 27—31 & January 31—February 3.**

Dates of spore showers 14—10 days before rust appearance ... ... **January 31—February 3 & February 3—7.**

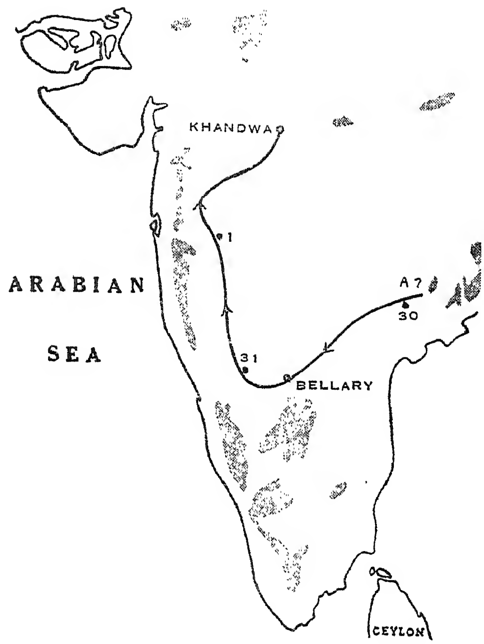
Date of rust appearance ... ... **February 17, 1935.**

B—The wind entered the country on January 25 and passed near Pottangi where 1 per cent crop infection with black rust was observed on January 8—9, 1935.

MAP NO. 24



MAP NO. 25



24. JUBBULPORE (1,289 ft. above sea level). BLACK RUST. ORIGINAL MAP No. 1,226.

Date and heights of trajectories in feet ... January 23, 1936 : C—4920, D—6560.

Dates of spore shower soon after the winds ... January 25—29.

Dates of spore shower 14—10 days before rust appearance ... ... February 1—4.

Date of rust appearance ... ... February 27, 1936 (Traces in middle of February 1936).

C—The wind was traceable from the sea-coast and passed near Mahableshwar where moderate crop infection with black rust was observed on January 5, 1936 and over Poona where black rust had appeared on December 23, 1935.

D—The wind was traceable from the sea-coast and passed near Poona where black rust had appeared on December 23, 1935.

25. KHANDWA (1,044 ft. above sea level). BLACK RUST. ORIGINAL MAP No. 336.

Date and height of trajectory in feet ... January 2, 1934 : A—1640.

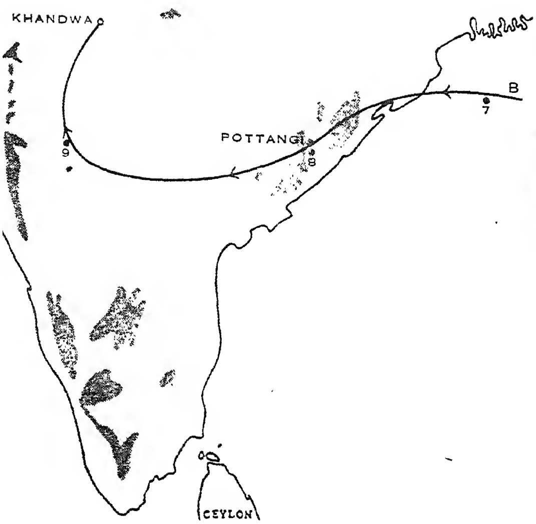
Dates of spore showers soon after the wind ... January 2—6 & 6—9.

Dates of spore shower 14—10 days before rust appearance ... ... January 16—20.

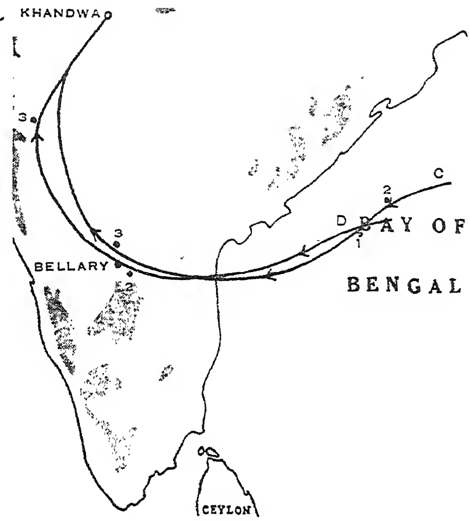
Date of rust appearance ... ... January 30, 1934.

A—The wind was traceable from the eastern border of Hyderabad State and passed over Bellary where up to 40 per cent crop infection was observed on December 11, 1933.

MAP NO. 26



MAP NO. 27



26. KHANDWA (1,044 ft. above sea level). BLACK RUST. ORIGINAL MAP No. 360.

Date and height of trajectory in feet ... January 10, 1934 : B—3280.

Dates of spore shower ... ... January 9—13**.

Dates of spore shower 14—10 days before rust appearance ... ... January 16—20.

Date of rust appearance ... ... January 30, 1934.

B—The wind entered the country from the Bay of Bengal on January 7 and passed over Pottangi the same day where 100 per cent crop infection with black rust was observed on January 13—14, 1934.

**The spore shower might have occurred on January 9, due to some earlier wind.

27. KHANDWA (1,044 ft. above sea level). BLACK RUST. ORIGINAL MAP Nos. 369 & 384.

Date and heights of trajectories in feet ... January 4, 1934 : C—4920, D—6560.

Dates of spore showers soon after the winds ... January 6—9 & 9—13.

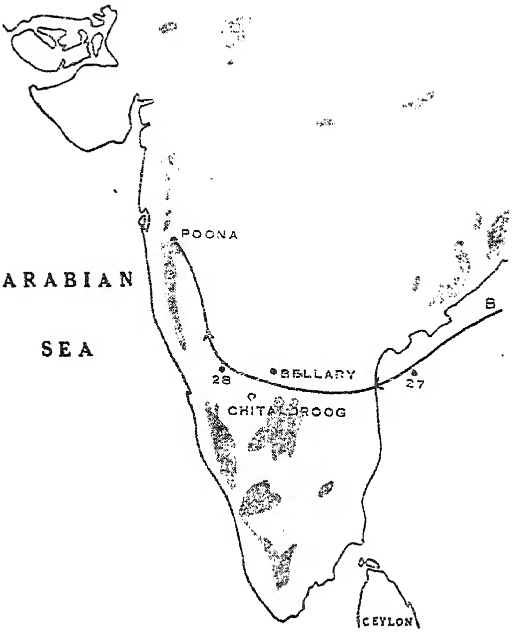
Dates of spore shower 14—10 days before rust appearance ... ... January 16—20.

Date of rust appearance ... ... January 30, 1934.

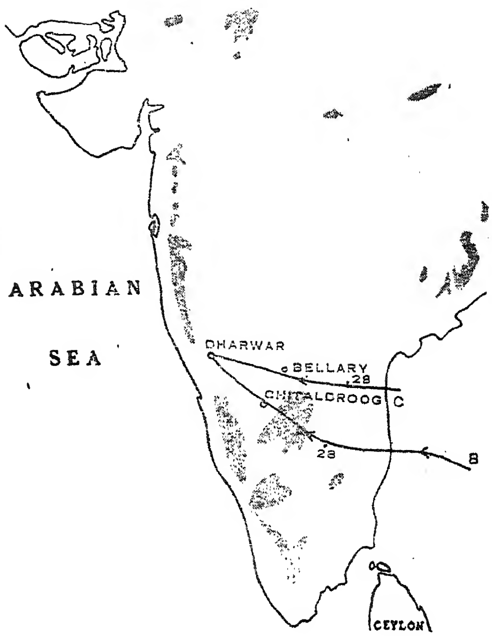
C—The wind entered the country from the Bay of Bengal on January 2 and passed near Bellary where up to 40 per cent crop infection was observed on December 11, 1933.

D—The wind entered the country from the Bay of Bengal on January 1 and passed over Bellary on January 2 where up to 40 per cent crop infection was observed on December 11, 1933.

MAP NO. 28



MAP NO. 29



28. POONA (1,834 ft. above sea level). BLACK RUST. ORIGINAL MAP No. 1,343.

Date and height of trajectory in feet ...	November 29, 1935 : B—3280.
Dates of spore showers	November 28—December 2† & December, 2—5.
Dates of spore shower 14—10 days before rust appearance	December 9—12, 1935.
Date of rust appearance	December 23, 1935.

B—The wind entered the country from the Bay of Bengal on November 27 and passed near Bellary where black rust had appeared on November 14, 1935 and Chitaldroog where 5 per cent crop infection had been observed on October 22 on crop sown in August 1935.

† The spore shower might have occurred on November 28, due to some earlier wind.

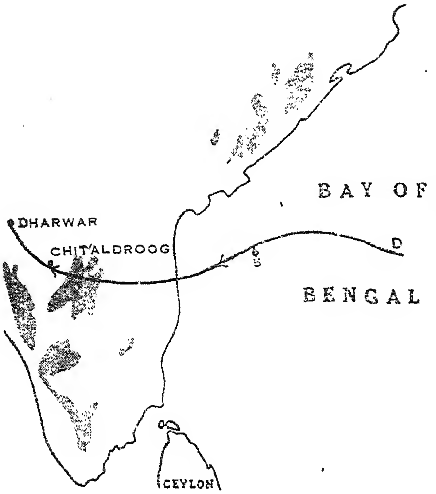
29. DHARWAR (2,340 ft. above sea level). BLACK RUST. ORIGINAL MAP No. 1,437.

Date and heights of trajectories in feet above sea level	December 29, 1935 : B—3280, C—4920.
Dates of spore showers soon after the winds ...	December 29—January 2 & January 2—6.
Dates of spore shower 14—10 days before rust appearance	January 2—6.
Date of rust appearance	January 15, 1936.

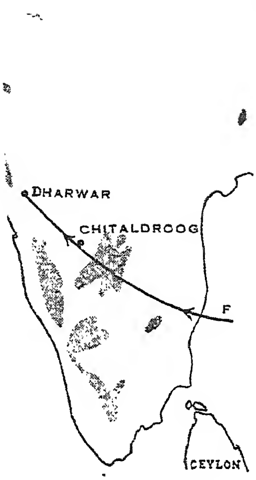
B—The wind was traceable from the Bay of Bengal and passed over Chitaldroog where 5 per cent crop infection with black rust was observed on October 22, 1935.

C—The wind was traceable from the Bay of Bengal and passed over Bellary where black rust had appeared on November 14, 1935.

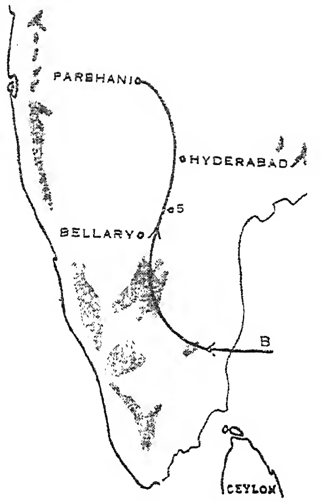
MAP NO. 30



MAP NO. 31



MAP NO. 32



30. DHARWAR (2,340 ft. above sea level). BLACK RUST. ORIGINAL MAP No. 980.

Date and height of trajectory in feet ... December 6, 1934 : D—6560.

Dates of spore showers soon after the wind ... December 7—11 & 11—15.

Dates of spore shower 14--10 days before rust appearance ... ... December 11 – 15, 1934.

Date of rust appearance ... ... December 28, 1934.

D—The wind entered the country from the Bay of Bengal on December 5 and passed over Chitaldroog where up to 50 per cent crop infection with black rust was observed on November 29—30.

31. DHARWAR (2,340 ft. above sea level). BLACK RUST. ORIGINAL MAP No. 1,432.

Date and height of trajectory in feet ... December 24, 1935 : F—9840.

Dates of spore shower soon after the wind ... December 29—January 2.

Dates of spore shower 14—10 days before rust appearance ... ... January 2—6.

Date of rust appearance ... ... January 15, 1936.

F—The wind entered the country on December 23, 1935 and passed over Chitaldroog where 5 per cent crop infection with black rust was observed on October 22, 1935.

32. PARBHANI (1,350 ft. above sea level). BLACK RUST. ORIGINAL MAP No. 1,445.

Date and height of trajectory in feet ... January 6, 1936 : B—3280.

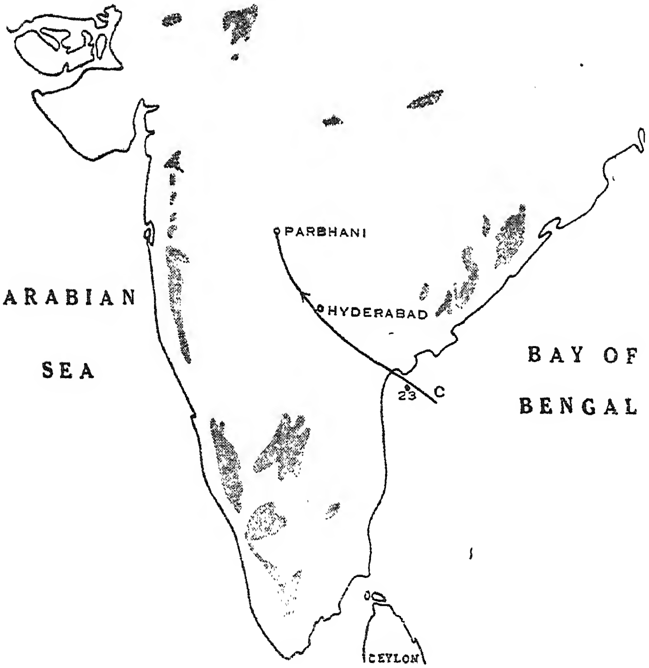
Dates of spore shower soon after the wind ... No spores were caught.

Dates of spore shower 14—10 days before rust appearance ... ... January 10—14.

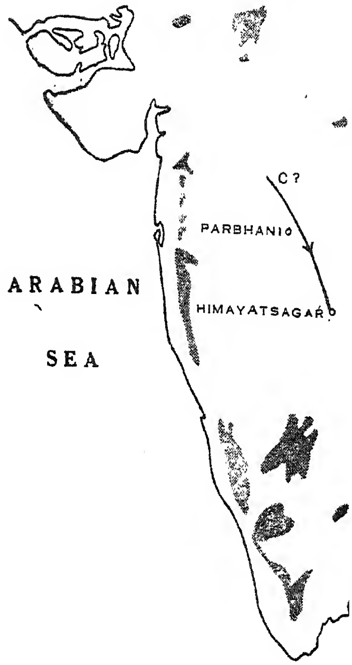
Date of rust appearance ... ... January 23, 1938.

B—The wind entered the country from the Bay of Bengal on January 4 and passed near and Hyderabad where black rust had appeared on November 14, and Bellary 9, 1935, respectively.December

MAP NO. 33



MAP NO. 34



33. PARBHANI (1,350 ft. above sea level). BLACK RUST. ORIGINAL MAP No. 1,432.

Date and height of trajectory in feet ... December 24, 1935 : C—4920.

Dates of spore shower soon after the wind ... No spores were caught.

Dates of spore shower 14—10 days before rust appearance ... ... January 10—14.

Date of rust appearance ... ... January 23.

C—The wind entered the country from the Bay of Bengal on December 23 and passed over Hyderabad where black rust had appeared on December 9.

34. HIMAYATSAGAR (1,776 ft. above sea level). BLACK RUST. ORIGINAL MAP No. 1,902.

Date and height of trajectory in feet ... January 19, 1937 : C—4920.

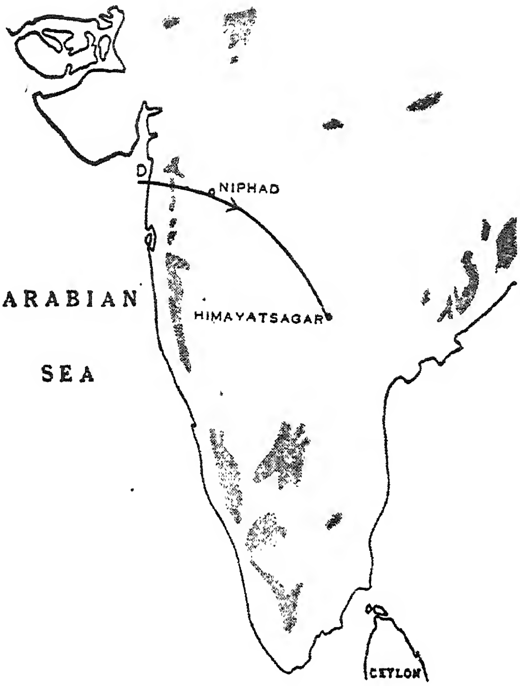
Dates of spore shower soon after the wind ... January 21—24.

Dates of spore shower 14—10 days before rust appearance ... ... January 24—28.

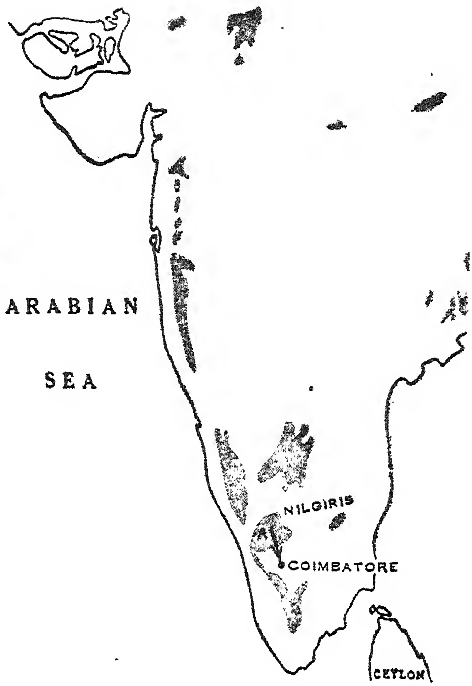
Date of rust appearance ... ... February 8, 1937.

C—The wind was traceable from the Central Provinces and passed near Parbhani where black rust appeared on January 3, 1937.

MAP NO. 35



MAP NO. 36



35. HIMAYATSAGAR (1,776 ft. above sea level). BLACK RUST. ORIGINAL MAP No. 1,900.

Date and height of trajectory in feet ... January 17, 1937 : D—6560.

Dates of spore shower soon after the wind ... January 21—24.

Dates of spore shower 14—10 days before rust appearance ... ... January 24—28.

Date of rust appearance .. ... February 8, 1937.

D—The wind entered the country from the Arabian sea and passed over Niphad where black rust had appeared on December 3, 1936.

36. COIMBATORE (1,341 ft. above sea level). BLACK RUST. ORIGINAL MAP. No. 1,934.

Date and height of trajectory in feet ... January 29, 1937 : A—1640.

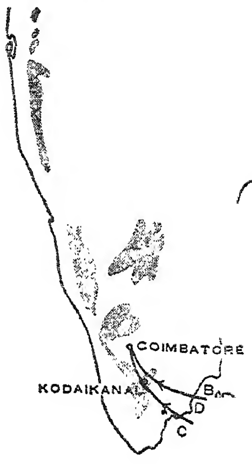
Dates of spore showers soon after the wind ... January 29—February 2 & February 2—6.

Dates of spore shower 14—10 days before rust appearance ... ... February 6—11.

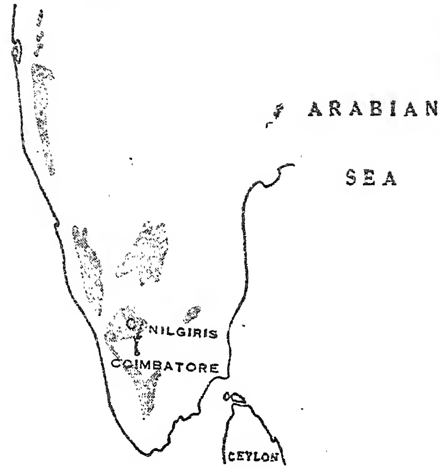
Date of rust appearance ... ... February 18, 1937.

A—The wind was traceable from the Nilgiri hills where up to 25 per cent crop infection was observed on October 1, 1936.

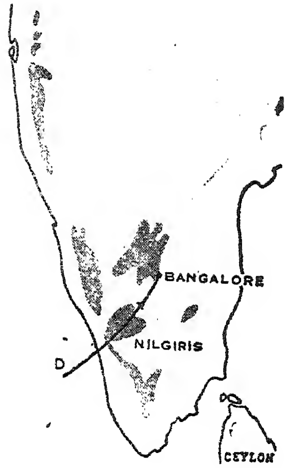
MAP NO. 37



MAP NO. 38



MAP NO. 39



37. COIMBATORE (1,341 ft. above sea level). BLACK RUST. ORIGINAL MAP No. 1,936.

Date and heights of trajectories in feet ...	January 31, 1937 : B—3280, C—4920, D—6560.
Dates of spore showers soon after the winds ...	February 2—6 & 6—11.
Dates of spore shower 14—10 days before rust appearance	February 6—11.
Date of rust appearance	February 18, 1937.

B & D—The winds after entering the country passed near Kodaikanal where black rust in traces was observed on October 10, 1936.

C—The wind after entering the country passed over Kodaikanal where black rust was observed in traces on October 10, 1936.

38. COIMBATORE (1,341 ft. above sea level). BLACK RUST. ORIGINAL MAP No. 346.

Date and height of trajectory in feet ...	January 12, 1934 : C—4920.
Dates of spore shower soon after the wind ...	No spores were caught.
Dates of spore shower 14—10 days before rust appearance	No spores were caught.
Date of rust appearance	February 3, 1934.

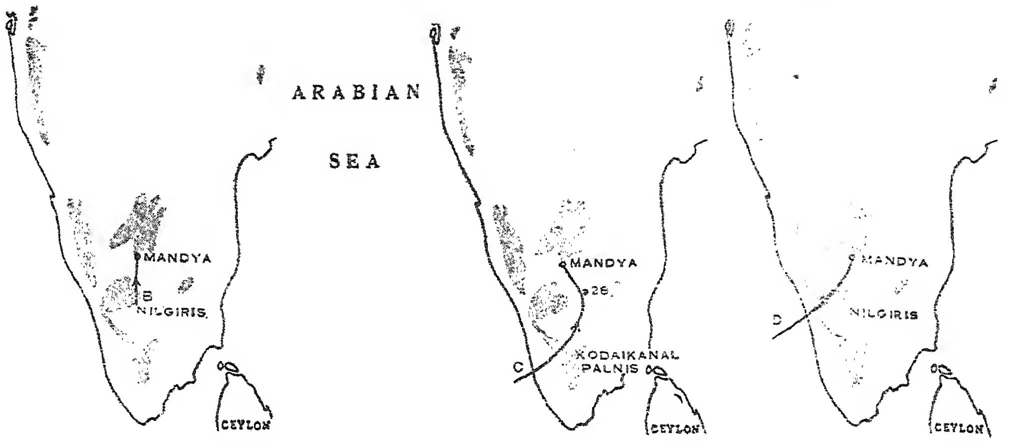
C—The wind was traceable from Nilgiris where 100 per cent crop infection with black rust was observed on December 24.

39. BANGALORE (3,021 ft. above sea level). BLACK RUST. ORIGINAL MAP No. 716.

Date and height of trajectory in feet ...	November 18, 1933 : D—6560.
Dates of spore shower soon after the wind ...	November 19—23.
Dates of spore shower 14—10 days before rust appearance	No spores were caught.
Date of rust appearance	December 18, 1933 (5—10 per cent infection in miniature plot).

D—The wind entered the country from Arabian sea and passed over Nilgiris where 100 per cent crop infection with black rust was observed on December 24, 1933.

MAP NO. 40 MAP NO. 41 MAP NO. 42



40. MANDYA (2,580 ft. above sea level). BLACK RUST. ORIGINAL MAP No. 2,451.

Date and height of trajectory	... ...	December 22, 1937 : B—8280.
Dates of spore shower soon after the wind	...	No spores were caught.
Dates of spore shower nearly 3 weeks before rust appearance	... ...	December 30—January 3.
Date of rust appearance	... ...	January 21, 1938.

B—The wind was traceable from Nilgiris where up to 100 per cent crop infection with black rust was observed on December 19, 1937.

41. MANDYA (2,580 ft. above sea level). BLACK RUST. ORIGINAL MAP No. 1,480.

Date and height of trajectory in feet	...	September 29, 1935 : C—4920.
Date of spore shower soon after the wind	...	September 30—October 3.
Date of spore shower 14—10 days before rust appearance	... ...	September 30—October 3.
Date of rust appearance	... ...	October 16, 1935.

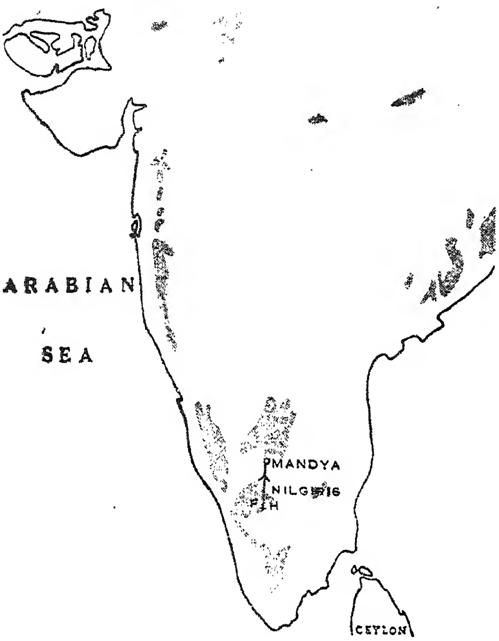
C—The wind entered the country from Arabian sea and passed near Kodaikanal (Palnis) where up to 20 per cent crop infection was observed on September 28, 1935.

42. MANDYA (2,580 ft. above sea level). BLACK RUST. ORIGINAL MAP No. 716.

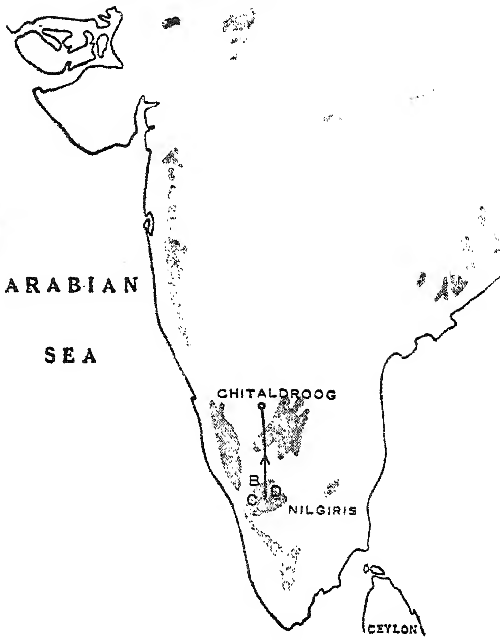
Date and height of trajectory in feet	...	November 18, 1933 : D—6560.
Dates of spore shower soon after the wind	...	No spores were caught.
Dates of spore shower 14—10 days before rust appearance	... ...	December 4—7.
Date of rust appearance	... ...	December 19, 1933 (On December 19, 10 per cent plant infection was observed in miniature plot.)

D—the wind entered the country from Arabian sea and passed over Nilgiris where 100 per cent crop infection with black rust was observed on December 24, 1933.

MAP NO. 43



MAP NOS. 44 to 46



43. MANDYA (2,580 ft. above sea level). BLACK RUST. ORIGINAL MAP No. 1,465.

Date and heights of trajectories* in feet	...	September 14, 1935 : F—9840, H—13120.
Dates of spore showers	... ...	September 19—23, 23—26 & 26—30.
Dates of spore shower 14—10 days before rust appearance	... ...	September 30—October 3.
Date of rust appearance	... ...	October 16, 1935.

F & H—The clouds were traceable from Nilgiris where 65--100 per cent crop infection with black rust was observed on September 20, 1935.

*Based on cloud observations.

44 to 46. CHITALDROOG (2,405 ft. above sea level). BLACK RUST. ORIGINAL MAP Nos. 1,962, 1,963 & 1,966.

Dates and heights of trajectories in feet	..	November 9, 10 & 13, 1936 : B—2280, C—4920. D—6560,
Dates of spore shower soon after the winds	...	No spores were caught.
Dates of spore showers 14—10 days before rust appearance	... ...	November 17—21 & 21—24.
Date of rust appearance	... ...	No information (On January 2—8, 25—100 per cent crop infection was observed‡).

B, C & D—The winds were traceable from Nilgiris where up to 25 per cent crop infection with black rust was observed on October 1, 1936.

Detailed information regarding the total number of wind-trajectories studied, winds found to be 'relevant' as well as those 'possibly relevant' for all the heights taken together, has been supplied in Table VI.

Information about the relevancy of winds, separately for each height, is also given in Table VII.

10. Discussion

In a subject like this one has to reckon with several factors and rely mostly on evidence which at its best can only be circumstantial. In addition to the catching of spores, the object of this study, as stated in Part One, was to obtain whatever information one could get from wind-trajectories regarding the direction or directions along which dissemination of a particular rust may take place in different parts of the country from year to year.

The study of wind-trajectories has, from the start, been looked upon as auxiliary. Tables and foot-notes to the maps have been so planned as to give full information on the basis of which the reader can determine if there is any correlation between the dates of rust appearance, spore showers and the winds that may have brought the inoculum from stations where rust had appeared earlier. The various aspects of the dissemination of black rust are briefly discussed below. Factors applicable to all the three rusts are dealt with in Part Five, General Discussion and Conclusions:

(i) Dates of rust appearance in relation to spore showers

It is clear in a general way from Tables II and III that at most of the stations uredospores of black rust of wheat were caught four to two weeks before its outbreak locally.

On the other hand, no spore showers could be detected from the study of aeroscope-slides exposed at some of the stations during one or more seasons. It is difficult to ascribe any special reason to such misfits excepting the fact that heavy spore showers are not usually frequent in this country. Only on a few occasions were spores caught in large numbers on an aeroscope-slide, and one cannot safely conclude from negative data that the small amount of air that passed through the box of the aeroscope was truly representative of the contents of the huge volume of air covering the fields at a particular locality. Besides, only one aeroscope was placed at each station except two. Further, if spores settle down in still air and there is no disturbance at the time at ground level either, no spores may enter the box of the aeroscope although they will alight on the crop. The same applies to spores that might come down to the ground with rain drops if there is no wind blowing into the box of the aeroscope. This is fully discussed in Part Five.

One has also to reckon with the possibility of a discrepancy between the dates of spore showers and of rust appearance even after allowance has been made for the incubation period because of dry weather. This aspect of the question is also dealt with under General Discussion and Conclusions at the end of this Section. As stated before, at several stations rust actually appeared a few days earlier than the dates of observations. In Table II, therefore, spore showers that occurred within four to two weeks of the date of rust appearance were included although the incubation period even during the coldest part of winter in the plains of India should not exceed fourteen days.

ii) Spore showers in relation to winds

According to the observations made by Ukkelberg [1933], single uredospores of black rust of wheat should take, in still air, nearly 12 hours to alight on the crop from an height of 1,640 ft. Based on that calculation, from 6,560 ft. these spores should take 48 hours to come down to ground level. Spores in clusters and those adhering to dust particles should settle down much earlier. Keeping in view, however, the resence of convective winds during the day time and the possibility of air at different heights being in movement due to other winds, it was felt safest to provide for longer periods for the settling down of spores from winds at each of the heights under study. For instance, in the case of a wind at 1,640 ft. above sea level only the spore shower on a slide exposed one to two days after the arrival of the wind at the station concerned was taken into consideration, except for a station situated at 500 ft. above sea level or above for which a shower on the same day, if any, was also taken into account. Similarly, for winds at 3,280, 4,920 and 6,560 ft. above sea level only spore showers occurring on slides exposed after two to three, three to four and four to five days respectively were considered, making due allowance in every case for the height of the station concerned. For higher winds, the period was extended accordingly keeping in view the height of the station itself. In Table VI, therefore, all such winds as were followed by spore showers during the periods not strictly in accordance with the heights of the winds concerned have been shown separately and marked with a query.

It is unnecessary to refer to the details that have already been sup lied as foot-notes to Map Nos. 2-46 or the data summarized in Tables V, VI and VII. There seems to be a distinct correlation between most of the winds that have been reproduced on the maps and subsequent spore showers, as revealed by the study of aeroscope-slides, which led in all probability to rust outbreaks. Such winds which had started from or passed over a station or stations, where the rust in question had appeared one to two months earlier, are of special interest. For the reasons given under Methods of Study, some attention has also to be paid even to those winds which passed over stations where the date of rust appearance, as reported by a local observer, was only fifteen days or so earlier because the actual date might have been earlier still.

The writer is fully aware of a large number of misfits, which are hard to explain, but in view of the difficulties of this study, the positive evidence leaves little doubt regarding the dissemination of the rust in question by winds from localities of earlier outbreaks.

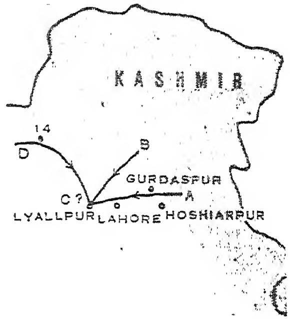
With regard to such wind-trajectories as could not be reproduced for the sake of economy of space and cost, full information has been supplied in Tables VI and VII to enable the reader to scrutinize the relative numbers of 'relevant', 'possibly relevant' and 'non-relevant' winds. In the case of some of the stations the number of 'relevant' winds taking the whole period together was very small and in others no such winds were found at all. This is difficult to explain fully.

At the same time, it is clear from Table VI that although no wind could be interpreted as 'relevant' for several stations during one year or more, in the light of information available, spore showers definitely occurred at most of them as revealed by the study of aeroscone-slides (Table II). By way of illustration some of the wind-trajectories which could not be interpreted as 'relevant' are reproduced on Map Nos. 47-54 and additional information for the stations

MAP NO. 47

MAP NO. 48

MAP NO. 49



47. LYALLPUR (605 ft. above sea level). BLACK RUST. ORIGINAL MAP No. 1,507.

Date and heights of trajectories in feet ... February 28, 1937 : A—1640, B—3280, C—4920, D—6560.

Dates of spore shower soon after the winds ... March 1—4.

Dates of spore shower 14—10 days before rust appearance ... ... March 8—11.

Date of rust appearance ... ... March 20, 1937.

A, B & D—Traceable from N.-W. F. Province and passed near Peshawar. Wind A passed Rawalpindi as well.

C—Traceable from Kashmir and passed over Murree and Rawalpindi. Black rust appeared at Peshawar on February 27, 1937.

48. LYALLPUR (605 ft. above sea level). BLACK RUST. ORIGINAL MAP No. 1,999.

Date and heights of trajectories in feet ... March 13, 1938 : A—1640, B—3280, C—4920, D—6560.

Dates of spore shower soon after the winds ... March 14—17.

Dates of spore shower 14—10 days before rust appearance ... ... March 21—24.

Date of rust appearance ... ... April 1, 1938.

A, B, C & D—Traceable from N.-W. F. Province and passed near Peshawar where black rust appeared on March 3, 1938.

49. LYALLPUR (605 ft. above sea level). BLACK RUST. ORIGINAL MAP No. 2,001.

Date and heights of trajectories in feet ... March 15, 1938 : A—1640, B—3280, C—4920, D—6560.

Dates of spore shower ... ... March 14—17**.

Dates of spore shower 14—10 days before rust appearance ... ... March 21—24.

Date of rust appearance ... ... April 1, 1938.

A—Traceable from Siwalik range and passed near Hoshiarpur, Gurudaspur and Lahore.

B—Traceable from Kashmir.

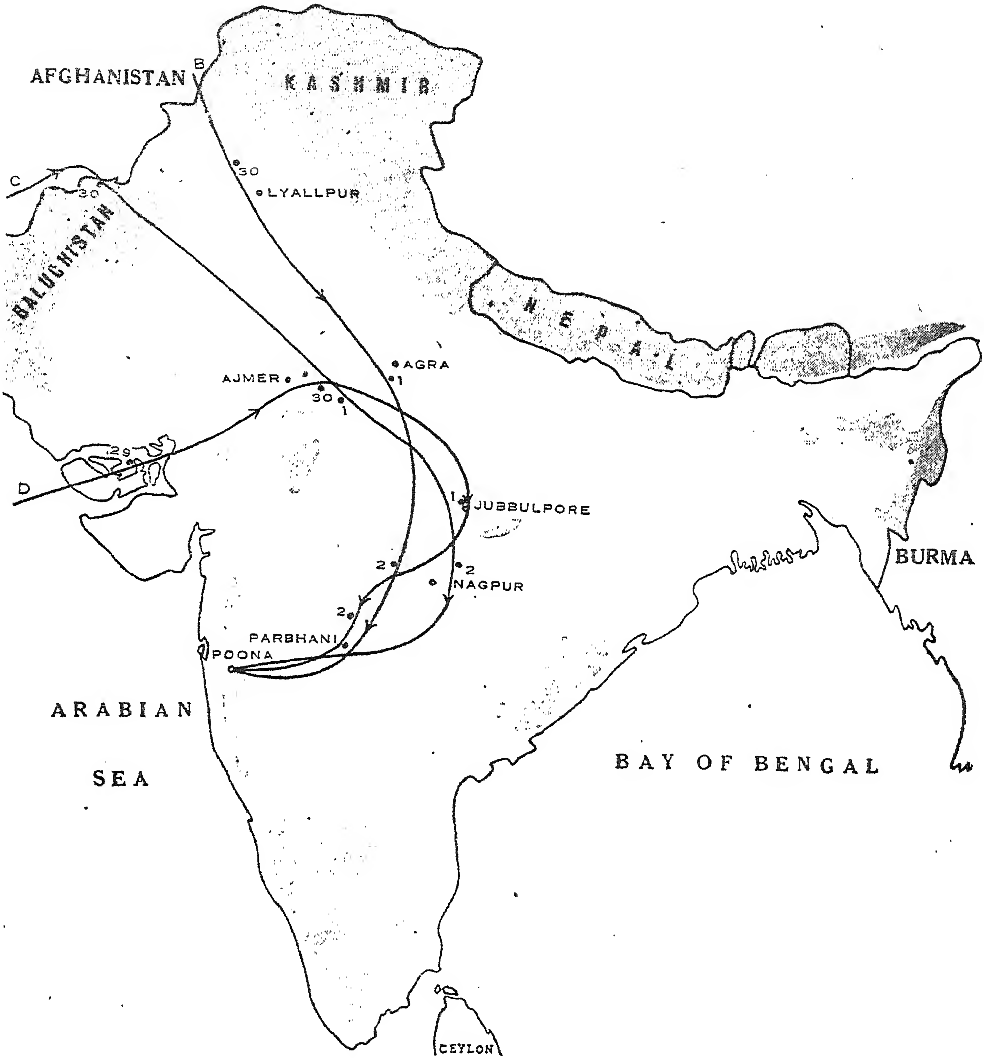
C—The wind was untraceable.

D—Traceable from N.-W. F. Province.

Black rust appeared at Gurudaspur on March 17.

**The spore shower might have occurred on March 14, due to some earlier wind.

MAP NO. 50



59. POONA (1,834 ft. above sea level). BLACK RUST. ORIGINAL MAP Nos. 231, 245 & 259.

Date and heights of trajectories in feet ...	December 3, 1933 : B—3280, C—4920, D—6560.
Dates of spore shower soon after the winds ...	December 4—7.
Dates of spore shower 14—10 days before rust appearance	Slides were not exposed after December 7.
Date of rust appearance	January 1st week, 1934.

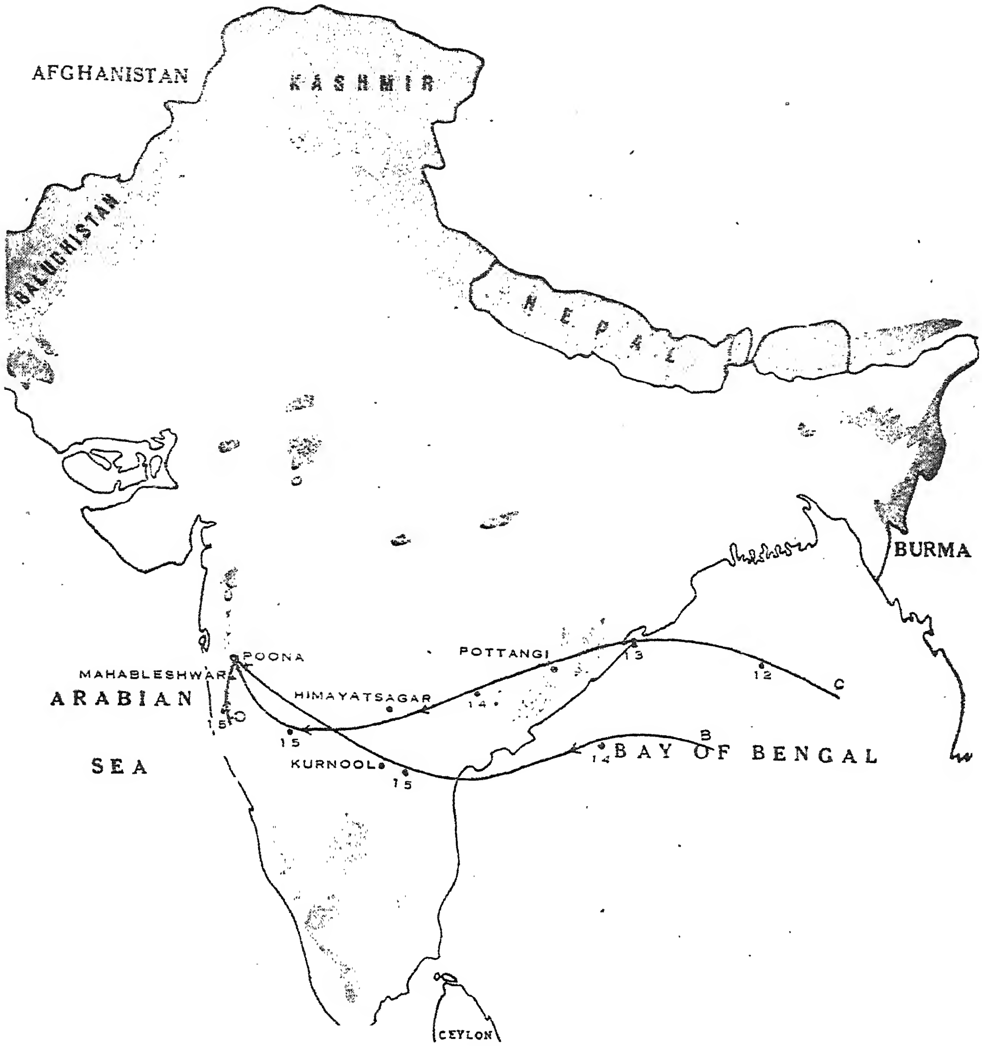
B—Traceable from Afghanistan and passed near Lyallpur, Agra and Parbhani.

C—Traceable from Afghanistan and passed near Jubbulpore, Nagpur and Parbhani.

D—Traceable from Arabian sea and passed near Ajmer, Jubbulpore, Nagpur and Parbhani.

Black rust appeared at Lyallpur in the 1st week of March, at Agra on February 6, at Parbhani on January 13, at Jubbulpore on January 28 and Ajmer on March 9.

MAP NO. 51



51. POONA (1,834 ft. above sea level). ORIGINAL MAP Nos. 999 & 1,000.

Date and heights of trajectories in feet ...	December 16, 1934 : B—3280, C—4920, D—6560.
Dates of spore shower soon after the winds ...	December 17–20.
Dates of spore showers 14—10 days before rust appearance	December 27—31, December 31 -January 3.
Date of rust appearance	January 2nd week, 1935.

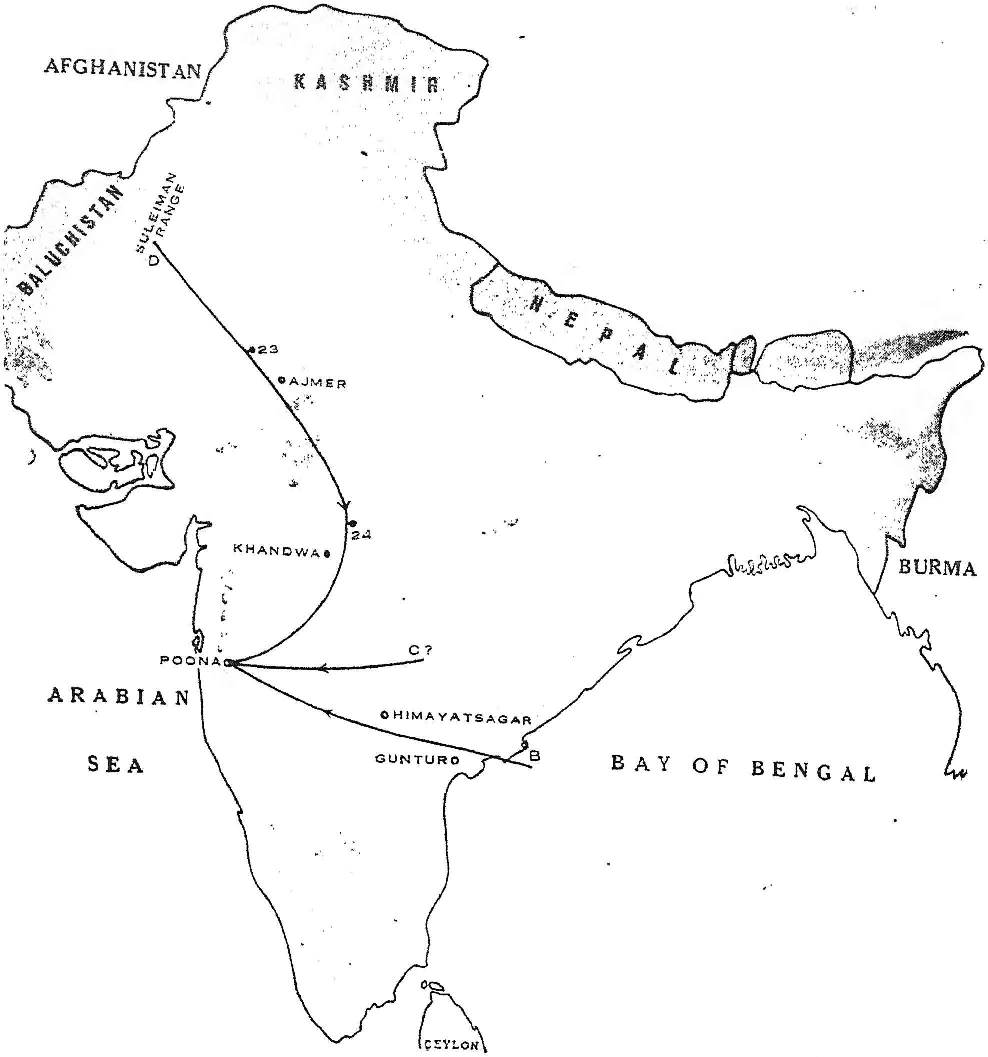
B—Traceable from the Bay of Bengal and passed near Kurnool.

C—Traceable from the Bay of Bengal and passed over Pottangi and Himayatsagar.

D—Traceable from Western Ghats and passed over Mahableshwar.

At Pottangi and Himayatsagar 1 per cent and up to 100 per cent crop infection was observed on January 8 and January 19 respectively.

MAP NO. 52



52. POONA (1,834 ft. above sea level). BLACK RUST. ORIGINAL MAP No. 1,854.

Date and heights of trajectories in feet	...	November 25, 1936 : B—3280, C—4920, D—6560.
Dates of spore shower soon after the winds	...	November 26—30.
Dates of spore shower 14—10 days before rust appearance	...	November 30—December 3.
Date of rust appearance ...	...	December 14, 1936.

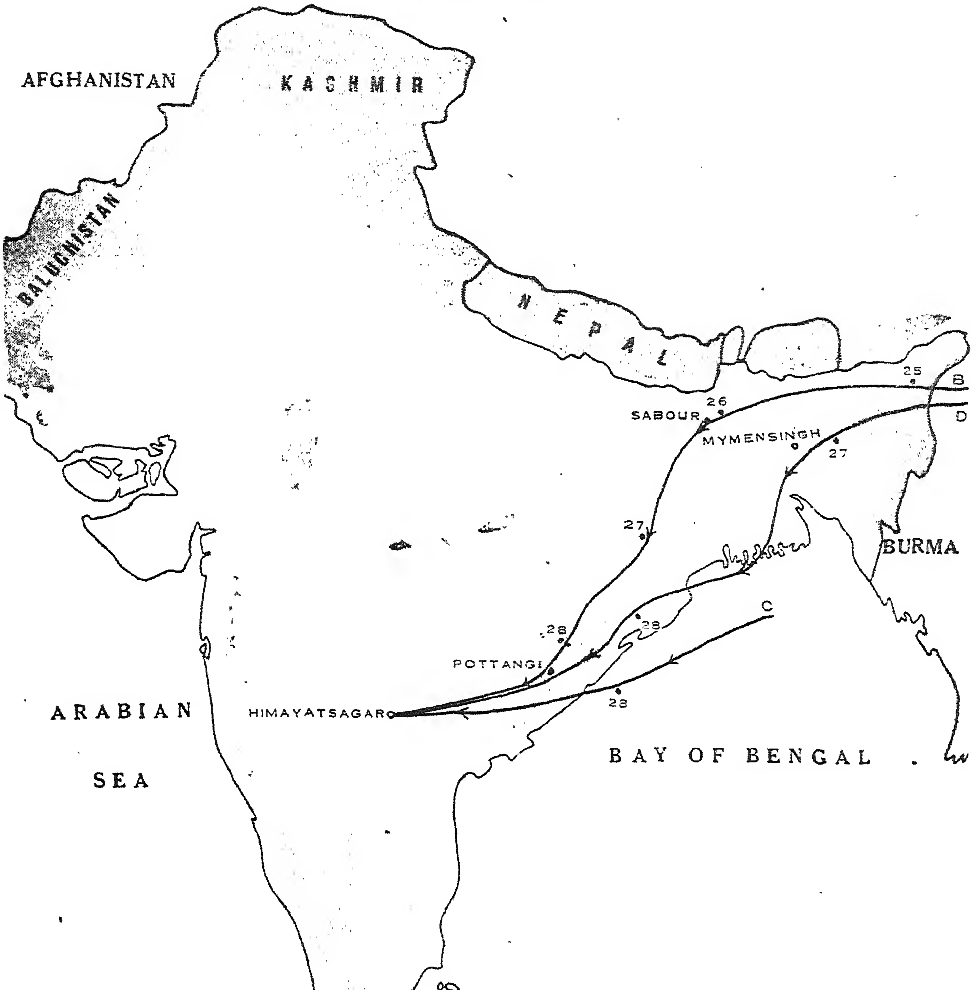
B—Traceable from the Bay of Bengal and passed near Guntur and Himayatsagar.

C—Traceable from Hyderabad state.

D—Traceable from Sulaiman range and passed over Ajmer and Khandwa.

Black rust appeared at Guntur in the 2nd week of January 1937 and at Himayatsagar (Hyderabad-Deccan) on February 8, 1937. Rust did not apppear at Ajmer that year and no information was available about Khandwa.

MAP NO. 53



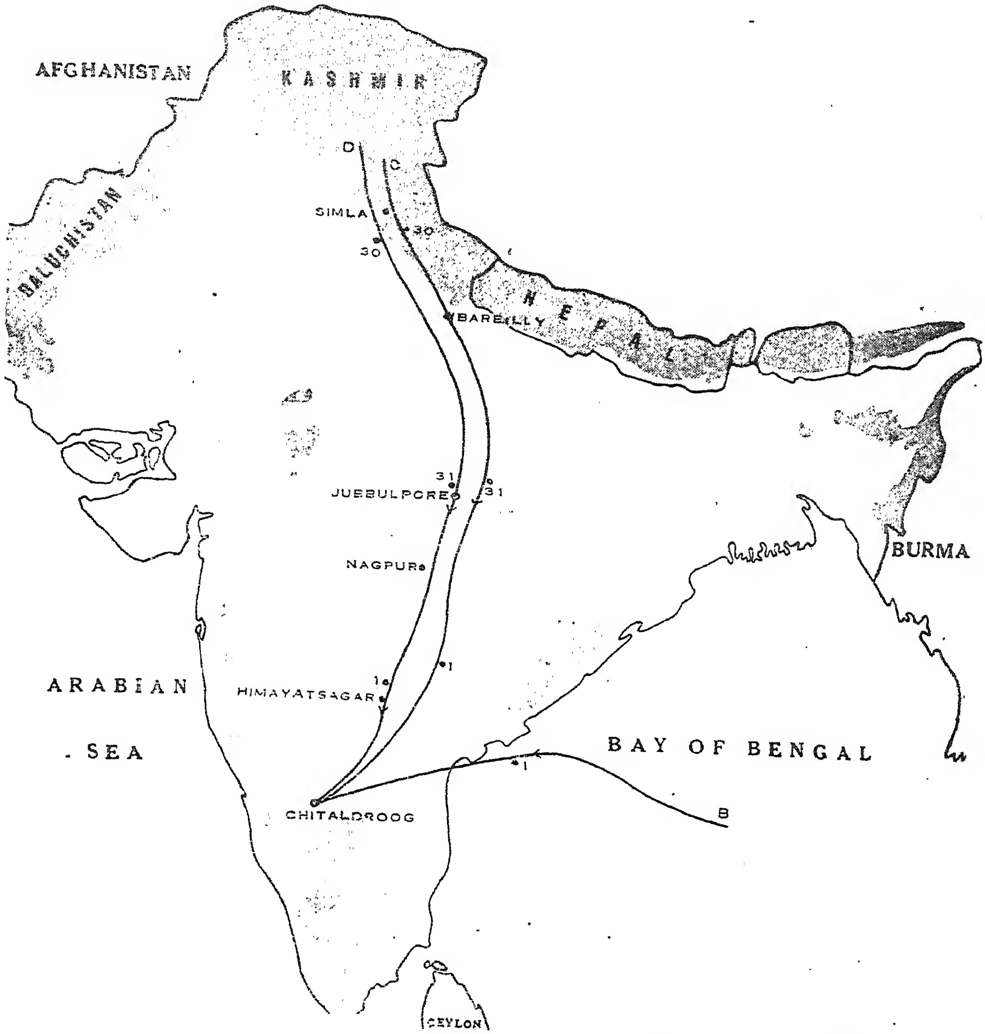
53. HIMAYATSAGAR (1,776 ft. above sea level). BLACK RUST. ORIGINAL MAP No. 701.

Date and heights of trajectories in feet	...	November 29, 1933 : B—3280, C—4920, D—6560.
Dates of spore shower soon after the winds	...	November 30—December 7.
Dates of spore shower 14—10 days before rust appearance	...	November 30—December 7.
Date of rust appearance ...	...	January middle, 1934 (On January 20—21, 5—100 per cent. crop infection was observed, Probable date December 20 or so).

B—Traceable from Burma and passed near Sabour and Pottangi.
C—Traceable from the Bay of Bengal.
D—Traceable from Burma and passed near Mymensingh and Pottangi.

Black rust appeared at Sabour on March 8 and 100 per cent crop infection was observed at Pottangi on January 13—14, 1934.

MAP NO. 54



54. CHITALDROOG (2,405 ft. above sea level). BLACK RUST. ORIGINAL MAP No. 725.

Date and heights of trajectories in feet ...	November 2, 1933 : B—3280, C—4920, D—6560.
Dates of spore shower	October 31—November 3**.
Dates of spore shower 14—10 days before rust appearance	No spores were caught.
Date of rust appearance	January 12, 1934 (On December 15, over 60 per cent crop infection was observed).

B—Traceable from the Bay of Bengal.
C—Traceable from Siwalik range and passed near Simla and over Bareilly.
D—Traceable from Siwalik range and passed near Simla, Jubbulpore, Nagpur and Himayatsagar.

Black rust appeared at Simla on March 15, at Bareilly on February 27, at Jubbulpore on January 28 and at Himayatsagar up to 100 per cent crop infection was observed on January 20—21, 1934.

** The spore shower might have occurred on October 31 or November 1, due to some earlier wind.

concerned is given below. Details are also supplied regarding three other stations for which trajectories were prepared for reasons explained in the text although no slides were exposed there. A summary of data supplied in Map Nos. 47-54 is given in Table VIII.

(*a*) *Lyallpur, 605 feet above sea level (Punjab).* For this station no 'relevant' winds were found during the years 1934-35, 1936-37 and 1937-38 but spore showers took place in all the three years, nearly four to two weeks before rust appearance.

In the year 1934-35 black rust appeared on March 20 and there was a spore shower on February 18 to 21, i.e. nearly a month earlier. Trajectories were studied for February 20 to March 5. On February 24 and 25 two winds which had passed over Hoshiarpur, where this rust was reported to have appeared in the first half of February, reached Lyallpur. For want of definite information about the date of first appearance of rust at Hoshiarpur neither of those winds could be regarded as 'relevant'. At three other stations passed over by the winds coming to Lyallpur rust appeared much later and from the rest no information was available. However, as shown in Table VI, there were 17 winds for Lyallpur coming from the hills that year. In view of the fact that black rust has been repeatedly found to oversummer in the uredostage in those areas such winds have been interpreted as 'possibly relevant'.

In 1936-37 rust appeared on March 20 and the last spore shower in relation to that date took place on March 1 to 4. Trajectories were studied for February 20 to March 7 and curves of February 28 are reproduced on Map No. 47. On March 1 to 4 some winds came from Kashmir and others passed over stations regarding which no information about the dates of rust appearance was available. The only place where rust had appeared earlier than at Lyallpur is Peshawar, where it broke out on February 27, i.e. only five days before the wind of March 4. No winds passing over Peshawar could, therefore, be regarded as 'relevant'. However, as shown in Table VI there were sixteen 'possibly relevant' winds for Lyallpur that year.

In the following year rust appeared on April 1 and the last spore shower in relation to that date took place on March 14 to 17. Trajectories were studied for March 1 to 16 and curves of March 13 and 15 are reproduced on Map Nos. 48 and 49. On the 14th one wind was untraceable and the other three followed the same course as winds of the 13th. Similarly, one of the winds of March 16 was untraceable and none of the other three passed over a station of known earlier appearance of the rust concerned. The only station where black rust appeared earlier than at Lyallpur is Gurdaspur, where it broke out on March, 17, i.e. one day later than the last date of wind-trajectories. No wind passing over Gurdaspur could, therefore, be regarded as 'relevant'. From other stations no information was available regarding the dates of rust appearance. As explained above two winds of the 15th from the Siwalik range and Kashmir might be regarded as 'possibly relevant' and the same applies to six other winds which came from the hills during the period for which trajectories were studied.

(*b*) *Poona, 1,834 feet above sea level (Bombay-Deccan).* No 'relevant' winds were found for this station, excepting one in the year 1935-36 although spore showers took place every year 4 to 2 weeks before rust appearance, with the exception of 1932-33. That year a spore was caught on the slide exposed during November 24 to 28 and rust appeared on December 5.

In the year 1933-34 rust appeared, as reported from this station, in the 1st week of January and several spores were caught on December 4 to 7. Trajectories were studied for December 1 to 15 and all the three curves of December 3 are reproduced on Map No. 50. On December 4 to 6, winds came from different directions but for want of space it seems unnecessary to reproduce them on ma s. On the 4th, however, two winds also came from the Siwalik range and the only station passed over, about which information was available, is Agra where rust appeared as late as February 6. Two winds of the 5th came from the Simla hills and passed over Agra and Jubbulpore (where rust appeared on January 28) and the third passed over Himayatsagar (Hyderabad-Deccan) near Nizamabad and Parbhani. One wind of December 6 came from Bengal and passed over Pottangi. Rust appeared at Parbhani on January 13. At Himayatsagar rust was reported to have a peared in the middle of January but heavy infection, 5 to 100 per cent, was observed by a member of the rust research staff on January 20 and 21 nevertheless a wind or winds of December 5 could not be taken as 'relevant'. At Pottangi a member of the rust research staff observed heavy infection, up to 100 per cent, on January 14 but in the absence of information regarding the date of first appearance at that station the wind of December 6 could not definitely be interpreted as 'relevant'. From other stations passed over by the winds, referred to above, no information was available regarding dates of rust appearance excenting Jhansi, where 50 to 60 per cent crop infection was observed as late as March 5 that year.

For Poona even winds from the Siwalik range or Simla Hills, where oversummering is so common, could not be taken as 'possibly relevant' because at intermediate stations like Agra and Jubbulpore rust anpeared much later. Such winds have not, therefore, been included in Tables VI and VII.

In 1934-35 rust appeared at Poona in the second week of January and spores were caught at the College farm on December 17 to 20 and 27 to 31. At the Observatory spores were caught on December 19 to 22. Trajectories were studied for December 8 to 23 and all the three curves of December 16 are reproduced on Map No. 51. On the next three days winds passed over Himayatsagar (Hyderabad-Deccan) and Bellary (wherefrom no rust was reported that year). The date of rust appearance at Himayatsagar was reported to be January 15 but 1 to 100 per cent crop infection was observed by a member of the rust research staff only four days later; nevertheless winds passing over that station as early as December 16 to 19 could not be regarded as definitely 'relevant'. Black rust was found to be oversummering at Mahableshwar in May 1934 but for want of information regarding its incidence at a later period the wind of December 16 passing over that station could not be included in the list of 'possibly relevant' winds. There was no other wind from a station of known earlier appearance of the rust concerned.

In 1936-37 rust appeared on December 14 and the spore shower in relation to that date occurred on November 26 to 30. Trajectories were studied for November 14 to 29 and all the three curves of November 25 are reproduced on Map No. 52. On November 26 to 29 the stations passed over, wherefrom information was available, are Pottangi, Himayatsagar (Hyderabad-Deccan). Parbhani, Agra, Jhansi, Jubbulpore and Niphad where rust appeared between December 3, 1936 and February 24, 1937. At Pottangi this rust was not found till November 29 that year.

In the year 1937-38 no rust was reported from Poona although spore showers occurred on December 14 to 17 and December 31 to January 4. Wind-trajectories were prepared for December 1 to 31 for the sake of comparison with

previous years. Out of 93 winds one was untraceable and none of the remaining winds, with the exception of two, which reached Poona on December 15 and 31 respectively, passed over a station or stations where rust had appeared rior to the periods of spore showers mentioned above. On December 15 and 31 two winds one on each occasion passed near Chitaldroog where 1 per cent crop infection had been observed on December 2 but neither of them could be taken as 'relevant' as no rust appeared at Poona that year. For the same reason winds of 1937-38 in the case of this station have not been included in Tables VI and VII.

With regard to Poona it is important to note that owing to its nearness to the Western Ghats some inoculum is likely to come down as a result of katabatic winds therefrom. The shortest straight distance between Poona and the Ghats is nearly 12 miles and black rust has occasionally been found to oversummer near Mahableshwar (4,500 ft. above sea level) and at some other places.

It may be mentioned that during 1932-33 and 1934 to 1937, taking all the three heights together, 8, 2, 14 and 5 winds respectively came to Poona from Mahableshwar or its neighbourhood and as stated above, there were spore showers also four to two weeks before rust appearance every year except in 1932-33. Such winds may, therefore, be taken as 'possibly relevant' but in the absence of fuller information regarding oversummering or earlier rust outbreaks in the Western Ghats than at Poona from year to year they could not be included in Tables VI and VII.

(*c*) *Himayatsagar, 1,776 ft. above sea level (Hyderabad-Deccan).* For this station there were no 'relevant' winds during three years out of four although spore showers occurred four to two weeks before rust appearance every year.

In the year 1933-34 rust appeared, as reported from this station, in the middle of January but very heavy infection, 5 to 100 per cent was observed by a member of the rust research staff on January 20 and 21. Spore showers took place on November 30 to December 7 and as shown in Table II also on December 17 to 22. Trajectories were studied for November 20 to December 5 and all the three curves of November 29 are reproduced on Map No 53. From November 30 to December 5 winds coming to Himayatsagar had passed over Gorakhpur, Patna, Karnal, Rawalpindi, Lyallpur, Agra, Jubbulpore, Simla, Bareilly, Shahjahanpur, Hoshiarpur and Dohad where rust appeared, one to two months later than at Himayatsagar, with the exception of Gorakhpur. At Gorakhpur 20 per cent crop infection was observed on January 15. None of the winds, referred to above could, therefore, be taken as 'relevant' and the same applies to some of the winds that came from Kashmir or the Simla Hills during December 1 to 5 because of the late appearance of rust at intermediate stations.

In 1934-35 rust was reported to have appeared on January 15 but a member of the rust research staff observed 1 to 100 per cent crop infection at this station on January 19. Spore showers took place on November 22 to 26 and December 5 to 9, 9 to 13 and 13 to 16. In view of the probable earlier appearance of rust wind-trajectories were prepared for a longer period, i.e. November 19 to December 10. For want of space it seems unnecessary to reproduce those winds on maps. Winds of November 21 to 25 had passed over Agra, Rawalpindi, Gurdaspur, Hoshiarpur, Gorakhpur, Benares, Lyallpur and Karnal, where rust appeared nearly two weeks to two months later than at Himayatsagar and no information was available from other stations. Nor was any station of earlier rust appearance passed over by the winds of December 4 to 10 and the same applies to other winds throughout the period of 22 days.

In the year 1935-36 rust broke out at Himayatsagar on December 9 and the nearest spore shower in relation to that date took place on November 19 to 22. Trajectories were studied for November 9 to 23. Winds of November 18 to 21 had passed over Agra, Simla, Dehra-Dun, Jubbulpore and Lyallpur where rust appeared 2 to 3 months later than at Himayatsagar and no information was available from the other intermediate stations.

It might be mentioned that during 1934-37, taking all the three heights (3,280, 4,920 and 6,560 ft. above sea level) together, 19, 14 and 2 winds respectively that had passed over or near Pottangi reached Himayatsagar four to two weeks before rust appearance and as stated above, there were spore showers also each year. Such winds may, therefore, be taken as 'possibly relevant' but for want of fuller information regarding oversummering in the Agency tract they have not been included in Tables VI and VII.

In view of the long distance between Himayatsagar and any centre of likely oversummering of rusts information was also obtained from anemograph records from Begumpet, near Himayatsagar, for the year 1935-36 to see, in a general way, if there were any winds from a station of earlier rust appearance during the intervals between daily meteorological observations. The height of the wind-vane of the anemograph at Begumpet is 61 ft. above ground. From the anemograph records it was found that five winds came from the south-west on November 2 to 27 and four from the south on November 18 to 20. It may be mentioned that in addition to the spore shower of November 19 to 22, recorded above, spores were found on aeroscope-slides exposed during November 3 to 7, 7 to 11, 11 to 16, 16 to 19, 22 to 26 and 26 to 30. No importance could, however, be attached to the information obtained from anemograph records because the winds were reported to be more or less 'calm'. Whereas it is not possible to state exactly the source of the inoculum it may be pointed out that 5 per cent crop infection with black rust had been observed at Chitaldroog (situated south-west of Himayatsagar) as early as October 22, 1935 on the crop sown in August that year.

Unlike Poona, there is no likelihood of any katabatic winds reaching Himayatsagar and it is quite likely, therefore, that the inoculum came to this station, as revealed by spore showers, from year to year with southerly winds during the intervals between the daily meteorological observations made in the mornings only. As stated in Part One, there is abundance of rust in the Nilgiris and Palni hills situated further south at that time of the year on the first crop, sown during April to August as well as on the second, sown in September to November.

(*d*) *Chitaldroog, 2,405 ft. above sea level* (*Mysore State*). No arrangements for the exposure of slides could be made at Chitaldroog itself and they were, therefore, exposed at Hiriyur, nearly 30 miles away. Chitaldroog was selected for repeated observations because of its nearness to Chikmaglur, a hilly station with an altitude of 3,400 ft. above sea level.

For this station no 'relevant' winds were found during four years out of six. No spore shower took place in relation to the date of rust appearance, as reported from there, in 1932-33 and slides were not exposed for several months in 1934-35. In other years spore showers did occur four to two weeks before rust appearance.

In the year 1933-34 rust appeared as reported from Hiriyur, nearly 30 miles from Chitaldroog, on January 12 on crop sown during October to November 1933. At Chitaldroog 1 to 10 per cent crop infection had been observed by a member

of the rust research staff on December 15, i.e. nearly a month earlier. At Siddavvanhalli, nearly 20 miles from Hiriyur, over 60 per cent infection was observed on December 15 on the crop sown during September. It may be mentioned that in addition to spore showers of October 31 to November 3 and December 9 to 12 spores were caught at Hiriyur on November 27 to 30, November 30 to December 3 and December 3 to 6. Trajectories were studied for November 1 to 16 and three curves of November 2 are reproduced on Map No. 54. Some of the winds of November 1 to 16 had passed over Simla, Dehra Dun, Bareilly, Agra, Gorakhpur, Benares, Bellary, Jubbulpore and Nagpur where rust appeared nearly 1 to 3 months later. None of the winds could, therefore, be regarded as 'relevant' or even 'possibly relevant'.

Exposure of slides at Hiriyur was suspended for nearly five months after July 16, 1934 for no obvious reason, consequently one could not be sure of any spore showers or their absence during that period. Rust was reported to be absent from Chitaldroog that year but a member of the rust research staff observed 1 to 25 per cent and 1 to 50 per cent infection on November 29 and 30 at Doddasiddavvanahalli, nearly 10 miles from Chitaldroog and at Chitaldroog itself on crops sown during August to September and October respectively. At the time of observation there was plenty of teleuto-material and for that reason the date of rust appearance was put back by nearly a month. Trajectories were, therefore, studied for September 29 to October 14 but none of the winds had passed over a station of known earlier appearance of rust and about others there was no information.

In the year 1935-36 rust broke out at Hiriyur, as reported from there, on January 1 on crop sown in October to November 1935 but a member of the rust research staff found 5 per cent infection on October 22 at Chitaldroog on the crop sown in August. At Hiriyur spores were caught on September 30 to October 3. In view of the earlier appearance at Chitaldroog trajectories were studied for September 10 to 30 and during that period most of the winds came from the Western Ghats of the Madras Presidency. One wind came from the Bay of Bengal passing near Bangalore wherefrom no rust was reported that year. Another wind touched Mahableshwar but none of the winds, referred to above, could be regarded as 'relevant' or even 'possibly relevant' because there was no information of earlier rust appearance at any of the intermediate stations.

No information was received from Hiriyur about the appearance of rust in 1937-38. On December 2 a member of the rust research staff found 1 per cent infection on the August to September crop at Doddasiddavvanahalli. At Hiriyur spores were caught on November 13 to 16. Trajectories were studied for October 27 to November 17. Almost all the winds came from the Bay of Bengal and some of them passed over Bangalore or Bellary where rust appeared much later, i.e. on January 22 and 8 respectively, consequently no wind could be regarded as 'relevant' or even 'possibly relevant'.

Information from anemograph records maintained at Kodaikanal (Palni Hills) was obtained for the years 1935-36 and 1936-37. From September 14 to October 5, 1935 there were 21 winds from Kodaikanal south-east of Chitaldroog passing over the Nilgiris. The altitude of Kodaikanal is 8,000 ft. and that year up to 20 per cent infection with black rust was observed on September 28 on the first crop, sown in April to August. In the Nilgiris also, 65 to 100 er cent infection was observed on September 17 to 19 on the first crop. At Chitaldroog, as stated above, 5 per cent crop infection was observed on October 22 on the August sown crop. At Mandya, situated at the foot of the Nilgiris on the

north and on the way to Chitaldroog, 5 per cent infection was observed on October 16 in the miniature plot which had been sown in August at the request of the writer. It may be added that at Hiriyur spores were caught on aeroscope-slides during September 10 to 14 and, as recorded in Table II, also on September 30 to October 3. At Mandya there were regular spore showers during September 16 to 19, 19 to 23, 23 to 26, 26 to 30, September 30 to October 3 and October 7 to 10.

In 1936-37 also, there were 12 winds during November 2 to 17 coming from Kodaikanal where black rust broke out on October 10. In the Nilgiris as much as 100 per cent infection was observed in some of the fields on October 1 to 4 on the April to August crop. At Chitaldroog 25 to 100 per cent infection was observed in different fields on January 2 to 3 on the October-sown crop. Judging from the heavy infection one may safely conclude that the initial outbreak must have occurred at least a month earlier. Spores were caught at Hiriyur during October 31 to November 3, November 7 to 10 and 17 to 21. It might be mentioned, however, that at Mandya no rust was found in the miniature plot during the visits on September 23, October 24 and November 14, nor was its appearance reported later from that station but spore showers occurred on December 28 to 31, December 31 to January 5 and January 5 to 7. It may also be added that intimation was received from Mandya on December 4 that wheat in the miniature plot had dried up. The velocity of winds as recorded at Kodaikanal varied between 1 to 10 miles per hour and no importance could, therefore, be attached to them as carriers of inoculum to Chitaldroog but they are undoubtedly important from the point of view of dissemination of inoculum to the upper-air beyond the hilly areas.

Whereas no definite conclusions can be drawn regarding the locality wherefrom the inoculum came to Chitaldroog during the years 1935-36 and 1936-37, there is strong circumstantial evidence of dissemination having taken place from the Palnis or Nilgiris, possibly both in the former year, for which additional evidence was available from spore showers and date of rust appearance at Mandya as well. The same applies to the latter year, as far as the Palnis and Nilgiris are concerned, but the negative evidence from Mandya is difficult to explain unless there was a deviation in the course of winds or their width did not actually cover Mandya. Besides, there is no wheat cultivation at Mandya excepting a few beds in the Irwin Canal farm and the miniature plot measured only 21×15 yards. It was unfortunate that the plot at Mandya dried up, as stated in the intimation dated December 4 from there and it was not possible, therefore, to get any information about rust appearance subsequent to the periods of spore showers. It may also be mentioned that there was no rain at Mandya after November 11 that year and no information could be obtained about atmospheric humidity from there.

Information from anemograph records maintained at Bangalore was also obtained from Mandya for September to October 1935. At Mandya nearly 5 per cent crop infection with black rust was observed on October 16 in the miniature plot sown in August. From September 10 to 30 there were 20 winds, some of them with a velocity of 15 to 24 miles per hour, coming from the south-west in the direction of the Nilgiris. Spore showers occurred at Mandya from September 5 to 9, 9 to 11, 16 to 19, 19 to 23, 23 to 26, 26 to 30 and September 30 to October 3. That year 65 to 100 per cent infection was observed in the Nilgiris on September 17 to 19 on the first crop. The wind-vane at Bangalore is kept at a height of 54 ft. 9 in. above ground.

It may also be added that oversummering of black rust is likely to occur, at any rate occasionally, at Chikmaglur (3,400 ft. above sea level) in the Chitaldroog district itself and that might explain, at least partly, the absence of 'relevant' winds in some of the years when rust might have been disseminated by katabatic winds.

(*e*) *Pottangi, 3,000 to 3,500 feet above sea level* (*Jeypore Agency Area Orissa, Eastern Ghats*). As stated above, no arrangements for the exposure of slides in aeroscopes could be made at this station. Notwithstanding that, the agency area was included in the list of stations for the study of rust incidence because in the year 1933-34 a severe epidemic (100 per cent crop infection) was observed by a member of the rust research staff as early as January 13 to 14. For want of a more suitable station near the coast the writer felt that it would be interesting to obtain some information regarding the source of inoculum for this locality, particularly in view of suitable altitudes in the neighbourhood where oversummering of black rust at least appeared to be likely. Wind-trajectories were, therefore, prepared for two years, 1935-36 and 1937-38, during which rust was found at this station; the dates of observations are given in Table VI. In 1936-37 no rust was found there till November 29. None of the winds during the fifteen days (November 1 to 15) of 1935-36 had passed over a station of earlier rust appearance. The same applies to a period of nearly three weeks (December 12 to 31) of 1937-38. Some of the winds came from Nepal and Kashmir but on account of later appearance of rust at the intermediate stations they could not be regarded as 'relevant' or even 'possibly relevant'. Most of the winds came from the Bay of Bengal and it is not unlikely, therefore, that the inoculum was blown down from a focus of oversummering located in hills in the neighbourhood of Pottangi. None of the winds came from the Nilgiris or Palni Hills and as no aeroscope slides could be exposed at Pottangi, it is not possible to give any information about spore showers. For want of space, it is unnecessary to reproduce the wind-trajectories for this station.

(*f*) *Mymensingh*, 60 *ft. above sea level* (*Bengal*). In order to make sure if any inoculum is disseminated from the hills of the Bengal Presidency or those of Assam to the Indo-Gangetic plain, wind-curves were prepared for Mymensingh also for two years. In the plains of Bengal and Assam there is very little wheat and the same applies to the hilly areas. There is some wheat cultivation in private farms near Mymensingh where black rust was found on February 15. 1937 and February 27, 1938. No rust was reported from the Agricultural Station at Mymensingh during any of the four years, 1932 to 1936, when aeroscope-slides were exposed at that station and spore showers took place at different periods. During 1936 to 1938 slides were not exposed at the Agricultural farm as no wheat was sown there. Whereas 16 'relevant' winds were found during 1936-37, none of the winds of 1937-38 could be included in that category but there were five 'possibly relevant' winds that year. Fourteen out of sixteen winds of the former year came from central Nepal, where nearly 30 per cent infection with black rust had been observed on December 6, 1936

The scrutiny of data regarding the dissemination of black rust during 1938-40 has just been completed. For Poona there was no 'relevant' or even 'possibly relevant' wind in 1938-39 but in the following year as many as 13 winds were found to be 'relevant', taking the three heights together. For Himayatsagar there was only one 'relevant' wind in the year 1939-40 and none in the previous year. In 1938-39 one wind was found to be 'relevant' for Chitaldroog also.

Detailed information about these winds along with those for other stations will be supplied in a later article.

on the August to September crop. The other two winds came from the United Provinces hills and Murree (Kashmir hills) and passed over Fyzabad, where this rust broke out as early as the fourth week of December, 1936. In the year 1937-38 winds came from Bhutan, eastern Nepal, etc. about which no information was available. No wind-trajectories are reproduced for this station.

(*g*) *Dhubri, nearly 115 ft. above sea level* (*Assam*). For the reasons given above, wind-trajectories were also prepared for this station for 1936 to 1938. No arrangements could be made for the exposure of aeroscope-slides at this station. All the six winds of 1936-37 that were interpreted as 'relevant' came from central Nepal where, as stated above, nearly 30 per cent infection was observed with black rust on December 6, 1936 on the Aug st to September crop. In the year 1937-38 no 'relevant' winds were found as most of them came from Bhutan and eastern Nepal about which no information was available. However, five winds were found to be 'possibly relevant' that year. It is unnecessary to reproduce those wind-trajectories for want of space. Dates of observations and the incidence of rust are given in Table VI.

In view of the occurrence of spore showers in a large number of cases already discussed and of several others represented in Tables VI and VII, it is likely that the inoculum came with 'possibly relevant' winds that blew during the intervals between the daily meteorological observations. As stated in Part One, until the end of February 1937, working charts generally gave information regarding morning winds only. No information was, therefore, available regarding winds that might have blown between one morning and the next until March 1937, i.e. for a period of five years of this study out of six. It is also likely that the inoculum might have come from places of earlier outbreaks, of which there may be many, but wherefrom no information was available regarding the dates of rust appearance. Spore showers, if any, following such winds as were traced back to the hills in the Working Charts of the Meteorological Department and therefore interpreted as 'possibly relevant' are shown in Table VI.

(*iii*) *Stations of earlier rust appearance in the foot-hills and plains*

In addition to the stations where aeroscope-slides were exposed incidence of rusts has been studied at a large number of places in the plains from year to year. The earliest and usual dates of rust appearance at representative stations are given in Table IX in which foot-hill stations are marked with an asterisk.

(*a*) *Early outbreaks due to nearness to hills.* It is clear from Table IX that, in general, this rust breaks out in the foot-hills much earlier than at places farther off. It has repeatedly been found that plant for plant there is severer infection in the foot-hills than in the neighbouring plains.

This proves without doubt, as has been pointed out several times by the writer, that in India the source of rusts lies in the hills. Oversummering of black rust in the hills and hilly tracts of this country has been fully discussed in the previous monograph, [Mehta, 1940].

From Table IX it is also clear that this rust breaks out in the foot-hills of the Punjab much later than those of the Nepal range. The most obvious explanation of this phenomenon is that there is no early crop in the Punjab Hills or even in Kashmir whereas in some parts of central Nepal wheat is sown during August to September in addition to the normal crop.

(*b*) *Early outbreaks due to early crops in the plains.* It has been noticed that in Peninsular India black rust breaks out, as one would expect, much earlier at stations where there is an early crop. For instance, in the districts of Bellary, Kadur and Chitaldroog there is the so-called *mungari* crop, sown in July to August or even earlier. In 1931 the writer found 100 per cent infection on this crop at Bellary on December 28. At Chitaldroog this rust has been found several times fairly early (October to November) on the crop sown in July to August. Such places undoubtedly act as secondary foci for the neighbourhood and also supply considerable inoculum by dissemination to places farther off where wheat is normally sown during October.

(*iv*) *Winds in relation to initial rust outbreaks*

After scrutiny of data supplied in Table VI, it was observed that at least one 'relevant' or 'possibly relevant' wind was found to have reached most of the stations under study, as will be clear from the Table given below. It may also be added that out of a total of 88 records of rust appearance, spore showers occurred in 46, soon after the 'relevant' or 'possibly relevant' winds. Spore showers also occurred prior to 24 other records of rust appearance but they could not be attributed to any 'relevant' or 'possibly relevant' winds. In all these cases spores were caught nearly four to two weeks before the initial outbreaks of the rust concerned. No information about spore showers or their absence could be obtained for ten records because at some of the stations no slides were exposed during the season or for the period of four to two weeks before rust appearance. Of the remaining eight records spores were caught in two, only 14 to 10 days or so before rust appearance, and no spores were detected in others. A general summary of data regarding spore showers in relation to winds and records of rust appearance is given in Part Five, General Discussion and Conclusions.

Year	Number of stations for which trajectories were studied	Number of stations for which there was at least one 'relevant' or 'possibly relevant' wind		Number of stations for which there was no 'relevant' or 'possibly relevant' wind
		'Relevant'	'Possibly relevant' only	
1932-33	9	7	1	1
1933-34	18	9	4	5
1934-35	15	9	3	3
1935-36	14	9	2	3
1936-37	15	11	1	3
1937-38	17	5	9	3

(*v*) *Probable foci of infection*

Reference to the occurrence of rusts in the hills on self-sown wheat and barley during the interval between the harvest and the next sowing has already been made in Part One.

As far as black rust is concerned, well-advanced infection on the crop sown during August to September has been found as early as the first week of December in central Nepal at altitudes of 4,000 to 5,000 ft.

Similarly, there is abundance of this rust, at the time when wheat is sown in the plains of Peninsular India, on the first crop in the Nilgiris, sown in April to August.

In order to make sure of its dissemination from the Nilgiris at a time when there is no wheat anywhere in the plains of the north and Peninsular India, sowings were made at the request of the writer in miniature plots at Mandya and Coimbatore situated at the foot of those hills on the north and south respectively. At Mandya this rust broke out as early as the middle of October on wheat sown in August 1935, and at Coimbatore rust appeared on September 8, 1938 on wheat sown during June to July. In the previous year rust broke out on September 10 at Coimbatore on wheat sown during June to July.

The writer [Mehta, 1940] has pointed out already that black rust is able to oversummer in the uredostage even at altitudes of 3,000 to 4,000 ft., particularly in shade or near a water channel. It is likely, therefore, to survive the summer, at least occasionally, in the hilly areas of the Chitaldroog district, the Western Ghats, in the neighbourhood of Pottangi (Agency tract, Jeypore) as well as at places where temperature during summer does not exceed the range of 95° to 100°F. from day to day.

Oversummering of this rust is an established fact in all the hills in the north due to higher altitudes and consequently a milder summer.

In short, there is a wide range of foci in the Himalayan range, and on account of early crops those in central Nepal and the Nilgiris are the most dangerous.

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* A cyclostyled copy of this report was Kindly supplied by the author.

TABLE I

Study oj aeroscope-slides for b ck

Year	Period of exposure	Dates of first spore shower. Number of spores in brackets	Dates of spore shower, if any, 4 to 2 weeks before rust appearance. Number of spores in brackets	Date of rust appearance, as reported from the station	Date of observation, *if any, regarding incidence of rust
			PUNJAB		
			1. Lyallpur		
1929-30	January 4—March 30 ...	January 15—18 (1)	...	No rust	
1930-31	January 10—April 10 ...	January 14—17 (2)	No spores ...	April 1st week	
1931-32	November 21—April 5 ...	February 10—13 (6)	February 17—20 (20) February 20—24 (16)	March 11	
1932-33	November 27—April 4 ...	April 1—4 (1)	April 1—4 (1)	April 20	April 3rd week (traces)
1933-34	November 1—March 24 ...	November 4—8 (4)	No spores ...	March 1st week	
1934-35	November 1—April 1 ...	January 31—February 4 (1)	February 18—21 (1)	March 20 ...	March 22 (traces)
1935-36	November 2—April 7 ...	February 4—8 (2)	February 25—29 (1)	March 25	
1936-37	December 3—April 15 ...	February 1—4 (1)	March 1—4 (1)	March 20 ...	April 14 (1 per cent)
1937-38	December 1—March 31 ...	January 3—6 (1)	March 14—17 (1)	April 1	

* Observations w ade by mer of the ... staff o nall The infection, wherever quoted, to different fiel d different ties at th tion

TABLE II—*contd.*

Year	Period of exposure	Dates of first spore shower. Number of spores in brackets	Dates of spore shower, if any, 4 to 2 weeks before rust appearance. Number of spores in brackets	Date of rust appearance, as reported from the station	Date of observation, if any, regarding incidence of rust
			2. Gurdaspur		
1931-32	November 15—March 15...	February 25—28 (5)	...	No information	
1932-33	December 2—February 5...	December 29—January 2(1)	...	No rust	
1933-34	Nov mber 3—February 26	November 3—6 (3)	†	March 23	
1934-35	November 1—April 1 ...	December 12—16 (1)	March 26—29 (22)	April 10	
1935-36	November 1—April 2 ...	November 19—21 (1)	No spores ...	March 27	
1936-37	November 20—April 14 ...	November 4—7 (1)	March 6—8 (2)	March 25	
1937-38	December 1—April 13 ...	January 12—14 (1)	February 20—23 (2)	March 17	
			March 3—5 (1)		
			3. Rupar		
1931-32	November 25—March 4 ...	December 9—16 (1)	...	No information	
1932-33	January 1—10 ...	January 4—7 (3)	...	,,	
1933-34	January 17—February 1 ...	January 17—21 (1)	...	,,	
1935-36	November 15—March 27	March 10—13 (1)	...	,,	
1936-37	November 20—March 26...	January 1—5 (1)	...	No rust	
1937-38	December 6—March 11 ...	January 17—21 (2)	February 14—18 (1)	March 1st week	

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Year	Period of exposure	Dates of first spore shower. Number of spores in brackets	Dates of spore shower, if any, 4 to 2 weeks before rust appearance. Number of spores in brackets	Date of rust appearance, as reported from the station	Date of observation, if any, regarding incidence of rust
			4. Hoshiarpur		
1931-32	November 17—March 16...	January 16—19 (2)	...	No information	
1932-33	January 14—April 3 ...	January 27—31 (1)	February 17—21 (1)	Middle of March ...	March 22 (traces)
1933-34	November 1—February 6	December 8—11 (9)	No spores ...	February 1st week ...	Early in February (traces)
1934-35	November 5—March 26 ...	January 5—8 (2)	January 14—17 (1) January 29—February 1 (1)	February 1st half ...	March 18 (traces)
1935-36	November 1—April 8 ...	December 18—21 (1)	January 28—31 (2)	February 1st half	
1936-37	November 18—April 4 ...	December 15—18 (1)	...	No information	
1937-38	December 1—March 31....	January 13—16 (2)	...	,,	
			5. Rawalpindi		
1932-33	September 15—March 26	March 2—5 (1)	†	End of Apri	
1933-34	January 21—April 18 ...	March 4—8 (2)	April 1—5 (112)	April 19	April 19 (traces)
1934-35	November 23—April 1 ...	January 14—18 (1)	February 25—March 1 (3)	March 3rd week ...	March 24 (traces)
1935-36	November 8—April 3 ...	No spores ...	...	No rust	
1936-37	January 1—April 20 ...	December 25—30 (1)	...	,,	
1937-38	December 15—April 25 ...	January 21—24 (3)	...	No information	

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Year	Period of exposure	Dates of first spore shower. Number of spores in brackets	Dates of spore shower, if any, 4 to 2 weeks before rust appearance. Number of spores in brackets	Date of rust appearance, as reported from the station	Date of observation, if any, regarding incidence of rust
			6. Sim a*, 7,000 ft. above sea level		
1932-33	September 15—April 6 ...	December 21—25 (1)	March 9—13 (3)	March 29	
1933-34	November 1—February 24	November 8—15 (7)	February 21—24 (2)	March 15	
1934-35	July 2—April 24 ...	December 1—5 (1)	March 27—30 (49)	April 14	
1935-36	November 1—April 4 ...	November 27—30 (1)	March 11—14 (4)	March 28	
1936-37	October 3—April 14 ...	October 10—14 (2)	March 24—27 (1) March 27—31 (1)	April 13	
1937-38	November 1—May 23 ...	December 9—13 (1)	March 3—7 (2) March 7—10 (6)	March 22	
			7. Khanewal		
1933-34	December 3—March 7 ...	January 7—10 (1)	...	No rust	
1934-35	November 1—April 2 ...	February 3—6 (2)	No spores (March 10—13)‡ (2)	March 23 ...	March 23 (traces)
1935-36	November 7—April 5 ...	January 5—8 (1)	...	No rust	
1936-37	January 1—April 7 ...	January 6—9 (2)	...	,,	
1937-38	December 4—April 3 ...	March 2—5 (1)	...	No information	

* Observations for rust appearance at Simla were made by members of the rust research staff. Rust is able to oversummer at Siml. because of favourable weather

‡ Spores shower nearly 13—10 days only before rust appearanee

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Year	Period of exposure	Da es of first spore shower. Number of spores in brackets	Dates of spore shower, if any, 4 to 2 weeks before rust appearance. Number of spores in brackets	Date of rust appearance, as reported from the station	Date of observation, if any, regarding incidence of rust
			8. Karnal		
1933-34	October 15—March 3 ...	October 25—29 (1)	February 7—11 (2)	March 2	
1934-35	October 15—March 14 ...	December 31—January 3(5)	February 11—14 (1)	March 4 ...	March 6 (traces—60 per cent)
1935-36	October 15—March 16 ...	November 14—18 (1)	February 3—6 (5)	February 27 ...	March 20 (10—60 per cent)
1936-37	December 17—March 25	December 31—January 4(1)	February 22—25 (2) February 25—March 1 (1)	March 12	
1937-38	December 2—April 7 ...	January 27—31 (6)	February 10—14 (2)	March 10	
			BALUCHISTAN		
			9. Quetta		
1932-33	September 15—May 8 ...	January 11—14 (1)	...	No information	
1933-34	March 23—April 12 ...	March 23—April 2 (1)	...	"	
1935-36	November 5—December 16	No spores ...	...	"	
1936-37	November 21—April 24 ...	March 23—27 (1)	*	May 23	
1937-38	January 15—May 23 ...	No spores ...	No spores ...	May 24	

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TABLE td.

Year	Period of exposure	Dates of first spore shower. Number of spores in brackets	Dates of spore shower, if any, 4 to 2 weeks before rust appearance. Number of spores in brackets	Date of rust appearance, as reported from the station	Date of observation, if any, regarding incidence of rust
			N.-W. F. PROVINCE		
			10. Peshawar (Tarnab farm)		
1935-36	November 15—April 6 ...	December 4—8 (1)	No spores ...	March 1st week	
1936-37	December 28—February 12	December 28—January 4 (1)	February 5—12 (1)	February 27	
1937-38	November 28—March 1 ...	February 11—14 (4)	February 14—17 (1)	March 3	
			SIND		
			11. Karachi		
1932-33	September 8—December 22	October 16—20 (3)	...	No information	
			12. Sakrand		
1932-33	September 15—March 17	February 10—14 (2)	February 26—March 2 (11)	March 20	
1933-34	December 11—March 15	January 30—February 6 (1)	No spores (March 6—9)* (3)	March 17	
1934-35	November 5—April 4 ...	January 6—14 (1)	February 3—6 (2)	March 4 ...	March 7 (5—20 per cent)
1935-36	November 5—April 1 ...	January 13—16 (1)	February 4—7 (4)	February 28	
1936-37	December 3—March 25 ...	January 29—February 1 (5)	February 13—16 (3) February 25—28 (1)	March 13	
1937-38	November 27—March 15	February 20—22 (1)	March 1—3 Over 500) March 5—7 (16)	March 20	

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TABLE ontd

Year	Period of exposure	Dates of first spore shower. Number of spores in brackets	Dates of spore shower, if any, 4 to 2 weeks before rust appearance. Number of spores in brackets	Date of rust appearance, as reported from the station	Date of observation, if any, regarding incidence of rust
			DELHI		
		13. Delhi (Imperial Agricultural Research Institute)			
1936-37	November 17—March 15...	March 5—9 (3)	March 5—9 (3)	March 20	
1937-38	December 1 —April 2 ...	December 25—29 (1)	February 26—March 2 (1)	March 17 ...	March 20—21 (0—20 per cent)
			UNITED PROVINCES		
			14. Agra‡ (Bichpuri farm)		
1929-30	January 4—March 1 ...	February 25—26 (1)	No spores (February 25—26)‡‡ (1)	March 9 ...	March 9 (traces)
1930-31	December 31—February 21	January 21—24 (7)	January 21—24 (7)	February 22	
1931-32	November 28—March 15...	January 27—30 (3)	January 27—30 (3)	February 3rd week	
1932-33	December 17—March 10	December 31—January 3(1)	February 14—18 (7)	March 5	
1933-34	November 1—February 7	December 6—10 (1)	January 14—21 (1)	February 6	
1934-35	October 16—March 10 ...	January 27—30 (2)	January 27—30 (2)	February 13	
1935-36	October 18—February 1 ...	November 30—December 2 (3)	January 26—28 (1)	February 22	
1936-37	November 17—February 15	January 5—8 (5)	February 6—9 (3) February 9—12 (2)	February 24	
1937-38	November 20—March 13...	December 19—22 (2)	January 27—30 (1)	February 19	

‡ Observations for rust appearance at Agra were made by the writer or members of the rust rseaerch staff
‡‡ Spore shower 12—11 days only before rust appearance

TABLE

Year	Period of exposure	Dates of first spore shower. Number of spores in brackets	Dates of spore shower, if any, 4 to 2 weeks before rust appearance. Number of spores in brackets	Date of rust sppearance, as reported from the station	Date of observation, if any, regarding incidence of rust
			15. Gorakhpur		
1930-31	December 1—January 21	December 1—17 (1)	December 1—17 (1) December 17—18 (5)	December 30	
1931-32	December 14—March 4	December 18—26 (5)	...	No rust	
1932-33	September 27—February 7	November 19—22 (1)	December 6—12 (7)	January 10	January 10 (traces)
1933-34	October 15—January 18 ...	October 25—28 (1)	December 13—16 (2)	February 1st or 2nd week†	January 15 (20 per cent)
1934-35	October 15—March 7 ...	December 10—13 (1)	No spores	January 28 ...	January 28 (traces)
1935-36	October 15—March 21 ...	October 15—18 (1)	December 29—January 2(4)	January 15	January 30 (0-25 per cent)
1936-37	November 3—January 22	December 17—20 (1)	December 17—20 (1)	No information ...	January 5—6 (traces)
1937-38	November 15—March 15	December 31—January 3(2)	January 31—February 2(1)	February 20	
			16. Allahabad (Naini farm)		
1929-30	December 16—March 3 ...	February 12—17 (11)	...	No information	
1936-37	December 3—March 6 ...	January 9—20 (4)	January 9—20 (4)	February 2	February 20 (traces-20 per cent)
1937-3[illegible]	November 16—March 16	December 29—January 2(3)	January 6—10 (1)	February 1st week	March 10 (20-80 per cent)

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TABLE 'd.

Year	Period of exposure	Dates of first spore shower. Number of spores in brackets	Dates of spore shower, if any, 4 to 2 weeks before rust appearance. Number of spores in brackets	Date of rust appearance, as reported from the station	Date of observation, if any, regarding incidence of rust
			17. Cawnpore		
1930-31	January 17—March 10 ...	January 17—21 (7)	January 21—24 (18)	February 2nd week	
1931-32	November 15—February 7	No spores	...	No information	
1932-33	December 1—March 2 ...	January 16—19 (1)	January 16—19 (1)	February 1st week*	
1933-34	October 15—January 14; February 2—March 1	November 15—19 (1)	January 10—14 (5)	No information ...	March 10 (abundant)
1934-35	October 19—March 11 ...	November 16—19 (1)	December 7—10 (2)	December X'mas week ...	February 19 (traces)
1935-36	October 18—March 9 ...	December 6—9 (1)	...	No information	
1936-37	January 1—March 15 ...	January 1—4 (2)	February 1—5 (1)	No information ...	February 15 (5-30 per cent)
1937-38	January 13—March 18 ...	February 4—7 (1)	February 21—24 (3)	March 2nd week ...	March 11 (40-70 per cent)
			18. Bareilly (Nawabgunj	**farm)**	
1932-33	September 15—March 14	January 9—13 (1)	February 10—15 (30)	March 1st week	
1933-34	October 22—February 28	November 26—29 (1)	January 31—February 4 (2)	February 27	
1934-35	October 15—March 12 ...	January 26—29 (1)	February 19—22 (2)	March 6	
1935-36	October 15—March 9 ...	December 14—16 (1)	January 7—10 (1)	February 8 ...	
1936-37	November 15—March 20	November 15—17 (9)	...	No information	
1937-38	November 15—March 15	December 14—17 (2)	...	No information	

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TABLE —*contd.*

Year	Period of exposure	Dates of first spore shower. Number of spores in brackets	Dates of spore shower, if any, 4 to 2 weeks before rust appearance. Number of spores in brackets	Date of rust appearance, as reported from the station	Date of observation, if any, regarding incidence of rust
			19. Shahjahanpur		
1932-33	September 15—February 21	February 18—21 (1)	...	No rust	
1933-34	October 15—February 4 ...	October 15—18 (2)	January 14—17 (4)	February 1st week ...	February 1—2 (traces)
1934-35	October 15—March 9 ...	December 14—17 (1)	No spores ...	February 11	
1935-36	October 15—March 22 ...	January 10—14 (1)	January 21—25 (1)	No information ...	February 7 (traces)
1936-37	November 1—April 7 ...	December 29—January 2(1)	January 30—February 2 (1)	Middle of February	
1937-38	November 15—March 21	December 31—January 3(1)	January 28—31 (1)	February 22	
			20. Almora		
1932-33	October 26—March 2 ...	January 2—5 (3)	February 18—22 (1)	March 12	
			21. Tarikhet		
1933-34	October 20—March 15 ...	October 26—29 (3)	February 28—March 3 (1)	March 25	March 25—26 (5-10 per cent)
1934-35	October 15—March 26 ...	February 6—9 (1)	February 9—12 (7)	March 1	
1935-36	October 15—March 13 ...	November 18—21 (1)	...	No information	
1936-37	January 25—April 18 ...	February 2—5 (1)	...	No information	
1937-38	November 15—March 18	December 16—19 (3)	...	No information	

TABLE 'on.

Year	Period of exposure	Dates of first spore shower. Number of spores in brackets	Dates of spore shower, if any, 4 to 2 weeks before rust appearance. Number of spores in brackets	Date of rust appearance, as reported from the station	Date of observation, if any, regarding incidence of rust
			22. Jhansi (Bharari farm)		
1933-34	February 18—March 18 ...	February 18—21 (10)	† (1)	No rust	March 5 (50-60 per cent)
1934-35	October 15—March 23 ...	January 15—17 (1)	February 8—11 (4)	February 28	
1935-36	November 8—March 30	January 14—17 (4)	...	No information	
1936-37	November 11—February 8	January 4—8 (1)	January 22—25 (1)	No rust	February 21 (traces 40 per cent)
1937-38	November 15—March 21	January 7—10 (5)	...	No information	
			23. Benares		
1933-34	October 22— February 14	October 29— November 1(1)	January 31-February 4(15); February 4—7 (26)	February 20 ...	March 19 (100 per cent)
1934-35	October 15—March 15 ...	December 17—20 (2)	December 30—January 3(1)	January 27	February 21 (10-20 per cent)
1935-36	October 20—March 20 ...	January 3—7 (1)	...	No rust	
1936-37	November 1—March 17 ...	January 17—20 (1)	January 17—20 (1)	No information ...	February 18 (traces-10 per cent)
1937-38	November 20—March 26	January 14—17 (1)	January 14—17 (1)	No rust	January 31 (traces)

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TAB

Year	Period of exposure	Dates of first spore shower. Number of spores in brackets	Dates of spore shower, if any, 4 to 2 weeks before rust appearance. Number of spores in brackets	Date of rust appearance, as reported from the station	Date of observation, if any, regarding incidence of rust
			24. Fyzabad		
1934-35	November 15—March 13	December 2—5 (3)	December 29—January 1 (2)	Middle of January ...	March 6 (40-90 per cent)
1935-36	October 15—January 29 ...	November 30—December 3 (5)	January 26—29 (1)	February 17 ...	February 17 (traces)
1936-37	November 1—February 25	December 16—19 (1)	No spores	December 4th week ...	February 21 (traces-15 per cent)
1937-38	November 21—March 17	November 21—25 (2)	January 30—February 3 (4)	February 19	
			25. Dehra Dun		
1935-36	October 15—March 20 ...	November 21—25 (3)	February 27—March 2 (5)	No information ...	March 18 (traces)
1936-37	November 2—March 16 ...	February 15—18 (1)	...	No information	
1937-38	November 15—March 18	February 22—25 (6)	March 12—15 (4)	March 31	
			BIHAR		
			26. Pusa		
1931-32	November 15—March 2 ...	December 13—17 (1)	January 21—24 (6)	February 5	
1932-33	September 15—March 19	November 14—17 (1)	No spores	February 13	
1933-34	October 16—February 8 ...	November 16—20 (3)	January 18—22 (2) January 22—25 (1)	February 7	February 7 (traces)

TABLE II—*contd.*

Year	Period of exposure	Dates of first spore shower. Number of spores in brackets	Dates of spore shower, if any, 4 to 2 weeks before rust appearance. Number of spores in brackets	Date of rust sppearance, as reported from the station	Date of observation, if any regarding incidence of rust
			BIHAR—*contd.*		
			26. Pusa—*contd.*		
1934-35	October 15—March 11 ...	Novembe r 5—8 (1)	January 10—14 (1)	January 31	
1935-36	October 15—March 20 ...	December 6—10 (1)	January 14—17 (1)	February 9	
1936-37	November 20—April 30 ...	December 11—15 (1)	January 22—26 (1) January 26—29 (1)	February 11	
1937-38	November 15—March 21	November 29—December 2 (1)	February 10—14 (8)	March 3	
			27. Patna		
1932-33	September 15—February 21	January 18—21 (25)	February 14—18 (3)	March 6 ...	March 6 (traces)
1933-34	October 28—February 15	December 11—14 (8)	December 26—30 (2)	February 15	January 24—25 (traces)
1934-35	October 15—February 27	December 2—6 (12)	January 6—10 (4)	January 4th week ...	February 22 (10 per cent)
1935-36	October 15—March 16 ...	December 22—26 (1)	...	No information	
1936-37	November 27—April 9 ...	January 9—12 (1)	...	No rust	
1937-38	December 1—March 20 ...	January 15—18 (3)	February 8—11 (5)	No information ...	March 6—7 (traces-10 per cent)

TABLE *contd*

Year	Period of exposure	Dates of first spore shower. Number of spores in brackets	Dates of spore shower, if any, 4 to 2 weeks before rust appearance. Number of spores in brackets	Date of rust appearance, as reported from the station	Date of observation, if any, regarding incidence of rust
			28. Sabour		
1932-33	September 15—February 19	January 26—29 (3)	February 12—16 (2) February 16—19 (1)	March 1st week	
1933-34	November 14—March 8 ...	December 17—21 (1)	February 18—22 (200)	March 8	March 8 (traces)
1934-35	October 15—March 15 ...	January 14—17 (3)	February 18—21 (4)	March 8	
1935-36	October 16—March 16 ...	December 20—24 (2)	...	No rust	
1936-37	November 26—April 19 ...	December 13—17 (1)	...	No rust	
1937-38	November 21—March 24	December 23—26 (1)	No spores ...	February end of 2nd week	March 5 (0-66 per cent)
			BENGAL		
			29. Mymensingh		
1932-33	September 15—December 22	October 15—18 (1)	...	No crop	
1933-34	March 1—14	March 4—8 (1)	...	No rust	
1934-35	October 15—March 12 ...	March 6—9 (5)	...	No rust	
1935-36	October 15—December 31	October 15—18 (2)	...	No rust	
			ASSAM		
			30. Shillong		
1932-33	September 15—January 26	No spores	...	No crop	

TAB ontd

Year	Period of exposure	Dates of first spore shower. Number of spores in brackets	Dates of spore shower, if any, 4 to 2 weeks before rust appearance. Number of spores in brackets	Date of rust appearance, as reported from the station	Date of observation, if any, regarding incidence of rust
			RAJPUTANA		
			31. Ajmer		
1931-32	November 14—March 12	November 14—18 (1)	February 10—17 (1)	February 26	
1932-33	December 15—March 5 ...	February 27—March 2 (1)	No spores (February 27—March 2)* (1)	March 11	
1933-34	October 15—February 27	October 21—24 (3)	February 8—12 (1)	March 9	
1934-35	October 15—February 26	January 26—31 (1)	February 12—15 (1)	March 7	March 11 (20-30 per cent)
1935-36	October 15—February 1 ...	January 20—27 (1)	† ...	March 13	
1936-37	November 4—February 29	November 30—December 2 (3)	...	No rust	
1937-38	November 10—January 11	December 31—January 8(1)	...	No rust	
			32. Sriganganagar (Bikner State)		
1934-35	October 30—March 18 ...	February 4—9 (2)	February 4—9 (2)	March 1st week	
1935-36	October 31—March 31 ...	December 31—January 3(1)	...	No rust	
1936-37	November 17—March 18	December 8—11 (1)	...	No rust	
1937-38	December 14—April 5 ...	February 1—4 (1)	...	No rust	

* Spore shower 12 to 9 days only before rust appearance
† Slides were not exposed after February 1, 1936

TAB d

Year	Period of exposure	Dates of first spore shower. Number of spores in brackets	Dates of spore shower, if any, 4 to 2 weeks before rust appearance. Number of spores in brackets	Date of rust appearance, as reported from the station	Date of observation, if any, regarding incidence of rust
			CENTRAL INDIA		
			33. Indore		
1932-33	September 15—January 19	October 24—27 (25)	...	No rust	
1933-34	March 2—15 ...	March 2—5 (35)	...	No rust	
1934-35	October 15—March 14 ...	December 31—January 3(1)	January 3—7 (3)	February 3rd week ...	February 27 (100 per cent)
1935-36	October 15—March 19 ...	November 25—28 (2)	February 3—6 (10)	February 21	
1936-37	November 2—March 18 ...	January 7—11 (1)	January 28—February 1(10)	February 17 ...	March 17 (0-80 per cent)
1937-38	November 16—March 15	No spores	...	No rust	
			CENTRAL PROVINCES		
		34.	**Jubbulpore (Adhartal farm)**		
1931-32	December 8—March 4 ...	January 19—23 (2)	February 13—16 (1)	No information ...	March 3 (traces)
1932-33	September 16—March 2 ...	February 11—15 (8)	No spores (February 11—15)* (8)	February 25	
1933-34	October 15—January 27 ...	October 18—21 (1)	January 6—10 (5)	January 28	March 3 (5 per cent)
1934-35	October 15—March 29 ...	January 5—8 (1)	January 31—February 3(38)	February 17 ...	February 25 (40-50 per cent)

Spore show[illegible] 0 days onl[illegible] appeara[illegible]

TABLE

Year	Period of exposure	Dates of first spore shower. Number of spores in brackets	Dates of spore shower, if any, 4 to 2 weeks before rust appearance. Number of spores in brackets	Date of rust appearance, as reported from the station	Date of observation, if any, regarding incidence of rust
			CENTRAL PROVINCES—*contd.*		
			34. Jubbulpore (Adhartal Farm)—*concld.*		
1935-36	October 15—March 20 ...	December 16—20 (4)	January 25—29 (2) February 1—4 (3)	February 27 ...	February Middle (traces)
1936-37	November 7—February 10	December 9—12 (4)	January 9—13 (2)	End of January ...	February 24 (traces—100 per cent)
1937-38	November 15—January 19	No spores	† ...	February 14 ...	February 18—20 (traces—40 per cent)
			35. Nagpur		
1929-30	January 2—March 19 ...	No spores	...	No rust	
1930-31	January 3—March 20 ...	January 3—7 (2)	February 5—7 (5)	No information ...	February 21 (traces)
1931-32	November 20—March 7 ...	December 14—21 (1)	February 4—8 (1)	No information ...	March 6 (traces)
1933-34	February 28—March 15 ...	March 3—7 (6)	...	No rust	
1934-35	October 18—March 12 ...	December 26—31 (1)	January 16—20 (1)	February 2	
1935-36	November 20—March 11...	January 7—11 (1)	...	No rust	
1936-37	November 2—March 18 ...	January 15—19 (2)	...	No rust	
1937-38	November 13—March 12	January 8—12 (1)	...	No rust	

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Year	Period of exposure	Dates of first spore shower. Number of spores in brackets	Dates of spore shower, if any, 4 to 2 weeks before rust appearance. Number of spores in brackets	Date of rust appearance, as reported from the station	Date of observation, if any, regarding incidence of rust
			36. Khandwa		
1931-32	December 24—February 25	February 8—11 (2)	...	No rust	
1932-33	October 18—March 16 ...	January 30—February 2 (3)	February 23—27 (5)	March 14	
1933-34	October 20—January 26 ...	November 7—11 (1)	January 9—13 (2)	January 30	March 4 (15 per cent)
			37. Pachmarhi		
1932-33	December 12—February 12	No spores	...	No rust	
1933-34	March 4—17 ...	March 4—7 (14)	...	No rust	
1934-35	October 19—March 19 ...	No spores	...	No rust	
1935-36	October 15—March 21 ...	November 12—16 (5)	...	No rust	
1936-37	November 1—April 4 ...	January 3—6 ... (1)	...	No rust	
1937-38	November 15— March 21...	No spores	...	No rust	

TAB contd

Year	Period of exposure	Dates of first spore shower. Number of spores in brackets	Dates of spore shower, if any, 4 to 2 weeks before rust appearance. Number of spores in brackets	Date of rust appearance, as reported from the station	Date of observation if any, regarding incidence of rust
		38. Powarkhera near Hoshangabad			
1934-35	November 23—March 14	December 30—January 5 (38)	January 18—22 (8)	February 2nd week	
1935-36	October 16—March 14 ...	January 1—4 (3)	January 1—4 (3) January 29 February 1 (67)	February 14 ...	February 23 (3-100 per cent)
1936-37	November 8—March 15 ...	December 3—6 (1)	December 27—31 (5) January 3—7 (3)	January 19	
1937-38	November 15—March 21	January 6—10 (1)	January 17—20 (7) January 25—28 (6)	February 17 ...	February 17 (0-40 per cent)
		39. Saugor			
1936-37	December 22—February 25	January 3—7 (2)	January 14—17 (1)	No information ...	February 26 (traces-60 per cent)
1937-38	November 15—March 20	December 5—9 (10)	...	No rust	
		40. Raipur (Labhandi farm)			
1936-37	November 10—April 2 ...	February 2—5 (1)	February 2—5 (1)	February 22	
1937-38	November 15—March 17	February 14—17 (1)	February 14—17 (1)	March 1	

'ABLE —*contd*

Year	Period of exposure	Dates of first spore shower. Number of spores in brackets	Dates of spore shower, if any, 4 to 2 weeks before rust appearance. Number of spores in brackets	Date of rust appearance, as reported from the station	Date of observation, if any, regarding incidence of rust
			BOMBAY-DECCAN		
			41. Poona (College farm)		
1931-32	October 15—January 7 ...	October 15—19 (22)	October 22—26 (41)	November 2nd week	
1932-33	August 5—December 25	October 20—24 (1)	No spores †	December 5	
1933-34	September 21—December 7	September 25—28 (3)	December 4—7 (15)	January 1st week	
1934-35	October 22—March 7 ...	December 17—20 (2)	December 17—20 (2) December 27—31 (1)	January 2nd week	
1935-36	October 14—February 17	November 28—December 2 (6)	December 5—9 (4)	December 23	
1936-37	October 15—February 18	November 5—11 (1)	November 26—30 (3)	December 14	
1937-38	October 1—February 4 ...	November 30—December 3 (1)	‡ ...	No rust	
		42. Poona (Observatory tower 120 ft. above ground)			
1933-34	September 15—December 3	September 23—26 (1)*			
1934-35	November 10—January 23	November 11—13 (14)	December 19—22 (5)	No crop Dates of rust appearance as above	
1935-36	October 15—December 21	October 15—18 (8)	No spores ...		
1936-37	October 29—December 14	October 29—November 2 (1)	November 26—30 (2)		
1937-38	November 15—January 17	December 3—6 (1)	...		

* Slides were not exposed after December 3, 1933
† On a slide exposed during November 24 to 28, one spore was caught
‡ Spore showers also took place on December 14 to 17 and December 31, 1937 to January 4, 1938

TABLE 'ontd

Year	Period of exposure	Dates of first spore shower. Number of spores in brackets	Dates of spore shower, if any, 4 to 2 weeks before rust appearance. Number of spores in brackets	Date of rust appearance, as reported from the station	Date of observation, if any, regarding incidence of rust
			43. Niphad		
1931-32	October 22—January 17 ...	October 22—25 (47)	December 13—17 (3)	January 1st week	
1932-33	August 9—December 12	August 12—15 (9)	November 18—22 (4); November 25—29 (8)	December 11	
1933-34	September 15—January 15	October 3—6 (2)	December 22—26 (1)	January 10	January 24 (10 per cent)
1934-35	October 2—March 5 ...	December 7—11 (1)	January 1—4 (1)	January 27	January 23 (1 per cent)
1935-36	October 15—February 18	November 26—29 (3)	November 26—29 (3)	December 28	
1936-37	October 15—February 19	October 22—26 (1)	November 16—19 (2)	December 3	
1937-38	October 1—January 28 ...	November 30—December 3 (3)	December 7—10 (1)	January 2	
			44. Dharwar		
1931-32	October 22—January 17 ...	October 22—26 (30)	November 9—12 (3)	November 26	
1932-33	August 12—December 16	August 15—18 (6)	* ...	January 17	
1933-34	September 15—January 18	September 18—22 (2)	October 27—30 (1)	November 21 ...	December 7—8 (1-10 per cent)
1934-35	September 28—February 15	November 6—11 (3)	December 4—7 (5)	December 28	
1935-36	October 15—February 16	November 18—22 (2)	December 25—29 (10); December 29—January 2 (19)	January 15	

* Slides were not exposed after December 16, 1932

Year	Period of exposure	Dates of first spore shower. Number of spores in brackets	Dates of spore shower, if any, 4 to 2 weeks before rust appearance. Number of spores in brackets	Date of rust appearance, as reported from the station	Date of observation, if any, regarding incidence of rust
		44. Dharwar—*concld.*			
1936-37	September 20—February 20	November 9—13 (2)	November 23—26 (5)	December 10	
1937-38	October 5—February 8 ...	December 14—17 (1)	December 14—17 (1) December 21—24 (1)	January 5	
		45. Arbhavi (Belgaum)			
1932-33	August 8—December 15	October 17—20 (1)	December 12—15 (1)	January 2†	
1933-34	September 15—December 31	September 15—18 (1)	December 4—8 (1)	December 28	
1934-35	October 1—February 11 ...	No spores ...	...	No rust	
1935-36	October 15—February 18	October 15—19 (1)	November 2—5 (1) November 9—12 (3)	November 25	
1936-37	September 20—February 15	November 15—19 (1)	...	No rust	
1937-38	October 1—February 22 ...	December 28—January 1 (2)	...	No rust	

formation w[illegible] ived from [illegible] uguppi, which is 12 mi[illegible] away [illegible] Arbha[illegible]

TABLE 'ontd

Year	Period of exposure	Dates of first spore shower. Number of spores in brackets	Dates of spore shower, if any, 4 to 2 weeks before rust appearance. Number of spores in brackets	Date of rust appearance, as reported from the station	Date of observation, if any, regarding incidence of rust
			46. Dohad		
1931-32	October 24—January 19 ...	November 11—18 (3)	...	No information	
1932-33	September 3—January 7	December 3—7 (3)	‡ ...	March 22§	
1933-34	September 27—January 31	September 27—October 1 (1)	January 24—28 (8)	February 18	
934-35	October 1—March 7 ...	January 3—7 (1)	February 4—7 (1)	February 25	
1935-36	October 20—February 23	November 24—27 (1)	January 22—26 (1)	February 10	
1936-37	October 15—February 18	November 9—12 (3)	January 4—7 (1)	January 31	
1937-38	October 1—March 12 ...	November 15—19 (1)	...	No rust	
			47. Wagra (Gujrat)		
1932-33	July 20—January 25 ...	November 16—20 (3)	...	No rust	
1933-34	February 10—24 ...	February 10—14 7)	...	No rust	

‡ Slides were not exposed after January 7, 1933
§ Teleuto-stage was present in the sample despatched on March 22, 1933 from Dohad, hence the date is incorrect

Year	Period of exposure	Dates of first spore shower. Number of spores in brackets	Dates of spore shower, if any, 4 to 2 weeks before rust appearance. Number of spores in brackets	Date of rust appearance, as reported from the station	Date of observation, if any, regarding incidence of rust
			48. Baroda		
1932-33	September 21-November 23	October 12—15 (3)	* ...	March 1	
1933-34	September 15—February 19	September 15—18 (1)	January 26—29 (9)	February 17	
1934-35	September 15—February 12	December 18—22 (3)	February 2—5 (2)	February 18 ...	February 28 (50-100 per cent)
1935-36	October 15—March 13 ...	December 20—24 (2)	January 14—17 (1)	February 4	
1936-37	October 15—March 23 ...	October 23—27 (1)	January 8—12 (1)	January 28	
1937-38	October 1—February 4 ...	January 28—February 1 (1)	†	March 14	
			49. Broach		
1934-35	October 1—February 28 ...	No spores	...	No rust	
1935-36	October 21—February 18	January 2—6 ... (1)	January 27—30 (33)	February 16	
1936-37	October 21—February 27	November 13—17 (1)	December 15—18 (1)	January 3	
1937-38	October 1—February 4 ...	December 10—13 (1)	...	No information	

* Slides were not exposed after November 23, 1932
† Slides were not exposed after February 4, 1938

TABLE 'd.

Year	Period of exposure	Dates of first spore shower. Number of spores in brackets	Dates of spore shower, if any, 4 to 2 weeks before rust appearance. Numbe of spores in brackets	Date of rust appearance, as reported from the station	Date of observation, if any, regarding incidence of rust
			50. Jagudan (Mehsana)		
1932-33	October 7—December 8 ...	October 7—10 (1)	‡ ...	No information ...	February 1st week (traces)
1933-34	September 15—January 28	September 24—27 (1)	January 19—22 (2)	February 8	
1934-35	September 19—March 3	January 13—17 (2)	January 25—29 (5)	February 17 ...	March 4 (80-100 per cent)
1935-36	October 15—February 17	December 20—24 (1)	January 17—20 (3)	February 7	
1936-37	October 15—February 18	December 24—28 (1)	December 24—28 (1) January 11—14 (2)	January 29 ...	February 6 (0-100 per cent)
1937-38	October 1—March 31 ...	November 16—19 (1)	February 1—4 (1)	February 28	
			51. Amreli		
1932-33	October 10—January 12 ...	No spores ...	No spores ...	No information ...	End of December (traces)
1933-34	January 2—February 2 ...	January 2—5 (1)	...	No rust	
1934-35	September 15—February 22	January 27—30 (7)	January 27—30 (7)	February 15 ...	March 2 (50-80 per cent)
1935-36	October 16—February 16	December 20—23 (1)	January 6—10 (2)	January 4th week—February 1st week	
1936-37	October 15—February 26	November 16—19 (2)	November 30—December 4 (7)	December 20	
1937-38	October 2—March 14 ...	November 22—26 (2)	...	No rust	

‡ Slid[illegible] fter [illegible] mbe[illegible]

TABLE ontd.

Year	Period of exposure	Dates of first spore shower. Number of spores in brackets	Dates of spore shower, if any, 4 to 2 weeks before rust appearance. Number of spores in brackets	Date of rust appearance, as reported from the station	Date of observation, if any, regarding incidence of rust
			HYDERABAD-DECCAN		
			52. Parbhani		
1932-33	August 4—November 7 ...	September 14—17 (1)	* ...	January 19	
1933-34	September 18—January 31	September 21—25 (1)	December 23—27 (4)	January 13 ...	January 23 (0-10 per cent)
1934-35	September 15—March 10	November 22—26 (4)	November 26—30 (1) November 30-December 4 (5)	December 15	
1935-36	October 15—March 3 ...	November 23—27 (2)	No spores January 10—14 (2) (Not full two weeks)	January 23 ...	January 21 (2-100 per cent)
1936-37	December 25—March 27	December 28—January 1 (1)	† ...	January 3	January 1 (traces)
1937-38	October 7—February 10 ...	November 29—December 2 (20)	December 27—30 (1)	January 14	January 23—25 (0-2 per cent)
			53. Himayatsagar, near	**Hyderabad**	
1932-33	July 22—January 9 ...	No spores	No spores	January 1st week	
1933-34	September 21—January 9	October 9—13 (1)	November 30-December 7 (7) December 17—22 (1)	Middle of January ...	January 20—21 (5-100 per cent) ‡
1934-35	September 19—February 11	November 1—5 (1)	November 22—26 (2) December 5—16 (1, 2, 3)	January 15	January 19 (1-100 per cent) ‡

* Slides were not exposed after November 7, 1932
† Slides were not exposed before December 25, 1936
‡ Rust must have appeared a month or so earlier

TAB contd

Year	Period of exposure	Dates of first spore shower. Number of spores in brackets	Dates of spore shower, if any, 4 to 2 weeks before ru:t appearance. Number of spores in brackets	Date of rust appearance, as reported from the station	Date of observation, if any, regarding incidence of rust
			53. Himayatsagar near Hyderabad —*contd.*		
1935-36	October 15—February 15	October 15—18 (1)	November 19—22 (3) November 22—26 (1)	December 9	
1936-37	October 16—February 15	October 19—22 (1)	January 21—24 (4)	February 8	
1937-38	October 19—January 27 ...	January 5—9 (1)	No spores ... (January 5—9)†† (1)	February 20 §	
			54. Raichur		
1932-33	July 16—November 16 ...	No spores	...	No crop	
			MADRAS		
			55. Bellary (Hagari farm)		
1932-33	July 15—November 17 ...	October 21—24 (11)	...	No rust	
1933-34	September 15—January 18	October 20—23 (1)	November 13—17 (9)	December 10 ...	December 11 (10-40 per cent)
1934-35	August 17—February 22 ...	February 18—22 (2)	...	No rust	
1935-36	January 15—February 21	August 16—20 (3)	October 25—29 (3)	November 14 ...	November 14 (1-2 per cent)
1936-37	August 12—March 31 ...	December 19—23 (2)	No spores ...	January 1st week ...	January 8 (0-10 per cent)
1937-38	August 20—March 1 ...	November 27—30 (1)	December 10—14 (1)	January 8	January 8 (0-10 per cent)

†† Spore shower 14 to 10 days only before rust appearance

§ Abundance of Teleuto-stage was present in the sample that swas collected on February 20, 1938 at Himayatsagar. Rust must have appeared about a month earlier

TABLE *contd.*

Year	Period of exposure	Dates of first spore shower. Number of spores in brackets	Dates of spore shower, if any, 4 to 2 weeks before rust appearance. Number of spores in brackets	Date of rust appearance, as reported from the station	Date of observation, if any, regarding incidence of rust
			56. Coimbatore		
1932-33	July 15—December 19 ...	July 15—18 (3)	November 28—December 1 (1)	December 27	
1933-34	September 18—February 1	October 12—16 (1)	January 8—11 (1)	February 3	
1934-35	May 18—February 18 ...	July 3—5 (2)	...	No information	
1935-36	October 15—February 18	November 15—19 (1)	...	No rust	
1936-37	August 20— February 15 ...	August 24— 27 (2)	January 29—Febtuary 2 (2)	February 18	
1937-38	August 17-January 28 ...	August 31—September 3 (1)	No spores ... August 31—September 3(1)‡	September 10* ...	November 7-8 (0-100 pe cent)
			57. Guntur		
1932-33	July 15—November 15 ...	No spores	...	No rust	
1933-34	September 15—January 19	October 10—13 (3)	November 30—December 5 (2)	End of December ...	January 7 (5-25 per cent)
1934-35	July 17—February 19 ...	July 17—20 (1)	...	No information	
1935-36	January 14—February 25	July 5—9 (1)	...	No rust	
1936-37	August 15—March 9 ...	September 5—8 (1)	December 15—19 (1)	January 2nd week	
1937-38	September 2—January 17	No spores	...	No rust	

* In miniature plot at the r qu f the writer in June to July, 1937
‡ Spore shower onl to 7 day be rust appearance, incul ation likel to b week o Septemb

TAB on

Year	Period of exposure	Dates of first spore shower. Number of spores in brackets	Dates of spore shower, if any, 4 to 2 weeks before rust appearance. Number of spores in brackets	Date of rust appearance, as reported from the station	Date of observation, if any, regarding incidence of rust
			58. Koilpatti		
1932-33	July 25—December 30 ...	No spores	...	No crop	
			59. Anthiyur		
1936-37	August 22—January 25 ...	October 12—15 (1)	...	No rust	
			60. Udumalpet		
1937-8	September 7– February 18	January 11–14 (2)	January 14–18 (1)	No information ...	March 9 (0-80 per cent)
			MYSORE STATE		
			61. Hebbal near Bangalore		
1932-33	October 2– February 15 ...	January 23—27 (1)	...	No information	
1933-34	September 15—December 27	September 25—29 (1)	November 19—23 (2)	December 18† ...	December 18 (5-10 per cent)
1934-35	June 16—January 18 ...	December 5—9 (1)	...	No rust	
1935-36	September 17—January 2	November 24—27 (4)	...	No rust	
1936-37	September 25—March 20	October 21—26 (1)	...	No rust	
1937-38	September 27—March 4 ...	December 27—31 (1)	January 3—7 (1)	January 22	

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'ABLE *contd*

Year	Period of exposure	Dates of first spore shower. Number of spores in brackets	Dates of spore shower, if any, 4 to 2 weeks before rust appearance. Number of spores in brackets	Date of rust appearance, as reported from the station	Date of observation, if any, regarding incidence of rust
			62. Mandya (Mysore)		
1932-33	October 22—January 24 ...	November 18—22 (2)	...	No information	
1933-34	September 19—February 4	September 19—22 (1)	December 4—7 (1)	December 19† ...	December 19 (10 per cent)
1934-35	May 15—February 17 ...	September 17—20 (1)	October 18—22 (1)	November 10†	
1935-36	June 17—November 21 ...	September 5—9 (1)	September 30—October 3(6)	October 16†	
1936-37	August 15—March 29 ...	December 28—31 (1)	...	No information	
1937-38	August 20—February 28 ...	September 2—6 (1)	December 30—January 3(5)	January 21‡	
			63. Hiriyur (Chitaldroog)		
1932-33	October 14—January 17 ...	December 24—27 (13)	No spores	End of November =	
1933-34	September 21—January 11	October 5—9 (1)	December 9—12 (2) October 31—November 3(1)	January 12*	December 15 (over 60 per cent)o December 15 (1-10 per cent)††

† In miniature plots sown at the request of the writer in August

‡ In miniature plots sown at the request of the writer in September

= Information was received late in April after several reminders and may not be correct

* On crop sown in October-November at Hiriyur Farm

o On crop sown early in September at Siddavanahalli nearly 20 miles from Hiriyur

†† On crop sown in November at Chitaldroog nearly 30 miles from Hiriyur

Year	Period of exposure	Dates of first spore shower. Number of spores in brackets	Dates of spore shower, if any, 4 to 2 weeks before rust appearance. Number of spores in brackets	Date of rust appearance, as reported from the station	Date of observation, if any, regarding incidence of rust
			63. Hiriyur (Chitaldroog) —*contd.*		
1934-35	May 15—July 16 February 5—19	May 15 —19 (1)	+	No rust	November 29 (1-25 per cent)† November 30 (1-50 per cent)††
1935-36	June 20—February 25 ...	August 34—27 (1)	September 30—October 3§ (1)	January 1*	October 22 (5 per cent)‡
1936-37	August 15—January 23 ...	September 22—26 (1)	November 7—10 (2)	No information ...	January 2—3 (15-100 per cent)§§
1937-38	August 20—January 26 ...	August 24—27 (30)	November 13—16 (1)	No information ...	December 2 (1 per cent)†

* On crop sown in October-November at Hiriyur Farm

\+ No slides were exposed after July 16, 1934 till February 5, 1935

† On crop sown in August-September at Doddasiddavvanhalli nearly 20 miles from Hiriyur

†† On crop sown in October at Chitaldroog nearly 30 miles from Hiriyur. Teleuto-stage quite common

§ Slides exposed after October 15, 1935 were not examined

‡ On crop sown in August at Chitaldroog nearly 30 miles from Hiriyur

§§ On crop sown in October at Chitaldroog and Doddasiddavvanhalli nearly 30 miles and 20 miles from Hiriyur respectively

NOTE.—Slides were exposed in aeroscopes at 62 stations but two aeroscopes (Nos. 41 and 42) were exposed at Poona, hence the total number comes to 63

TABLE III

Summary of data given in Table II

Serial number.	Province and name of station	No. of years during which slides were exposed	No. of years when spore showers took place	No. of years when spores were caught 4 to 2 weeks before rust appearance	No. of years when no spores could be detected 4 to 2 weeks before rust appearance	No. of years when no rust appeared or no information was received regarding rust appearance
	PUNJAB					
1	Lyallpur	9	9	6	2	1
2	Gurdaspur	7	7	3*	1	2
3	Rupar	6	6	1	...	5
4	Hoshiarpur ...	7	7	3	1	3
5	Rawalpindi ...	6	5	2*	...	3
6	Simla	6	6	6	None	None
7	Khanewal	5	5	...	1	4
8	Karnal	5	5	5	None	None
	BALUCHISTAN					
9	Quetta	5	3	*	1	3
	N.-W. F. PROVINCE					
10	Peshawar	3	3	2	1	None
	SIND					
11	Karachi	1	1	...	...	1
12	Sakrand	6.	6	5	1	None
	DELHI					
13	Delhi	2	2	2	None	None
	UNITED PROVINCES					
14	Agra	9	9	8	1	None
15	Gorakhpur	8	8	6	1	1

* No slides were exposed during that period in one of the years

TABLE III—*contd.*

Serial number.	Province and name of station	No. of years during which slides were exposed	No. of years when spore showers took place	No. of years when spores were caught 4 to 2 weeks before rust appearance	No. of years when no spores could be detected 4 to 2 weeks before rust appearance	No. of years when no rust appeared or no information was received regarding rust appearance
	UNITED PROVINCES—*contd.*					
16	Allahabad	3	3	2	...	1
17	Cawnpore	8	7	6	...	2
18	Bareilly	6	6	4	...	2
19	Shahjahanpur ...	6	6	4	1	1
20	Almora	1	1	1	...	...
21	Tarikhet	5	5	2	...	3
22	Jhansi	5	5	2*	...	2
23	Benares	5	5	4	...	1
24	Fyzabad	4	4	3	1	None
25	Dehra Dun ...	3	3	2	...	1
	BIHAR					
26	Pusa	7	7	6	1	None
27	Patna	6	6	4	...	2
28	Sabour	6	6	3	1	2
	BENGAL					
29	Mymensingh ...	4	4	...	...	4
	ASSAM					
30	Shillong	1	No spores	...	...	1†
	RAJPUTANA					
31	Ajmer	7	7	3*	1	2
32	Sriganganagar ...	4	4	1	...	3
	CENTRAL INDIA					
33	Indore	6	5	3	...	3

* No slides were exposed during that period in one of the years

† There was no crop that year

TABLE III—*contd.*

Serial Number	Province and name of station	No. of years during which slides were exposed	No. of years when spore showers took place	No. of years when spores were caught 4 to 2 weeks before rust appearance	No. of years when no spores could be detected 4 to 2 weeks before rust appearance	No. of years when no rust appeared or no information was received regarding rust appearance
	CENTRAL PROVINCES					
34	Jubbulpore ...	7	6	5*	1	None
35	Nagpur	8	7	3	...	5
36	Khandwa	3	3	2	...	1
37	Pachmarhi	6	3	...	...	6
38	Powarkhera ...	4	4	4	None	None
39	Saugor	2	2	1	...	1
40	Raipur	2	2	2	Neither	Neither
	BOMBAY-DECCAN					
41	Poona (College farm) ...	7	7	5	1	1
42	Poona (Observatory Tower 120 ft. above ground) ...	5	5	2†*	1	1
43	Niphad	7	7	7	None	None
44	Dharwar ...	7	7	6*	None	None
45	Arbhavi	6	5	3	...	3
46	Dohad	7	7	4*	...	2
47	Wagra	2	2	...	...	2
48	Baroda	6	6	4‡	None	None
49	Broach	4	3	2	...	2
50	Jagudan	6	6	5*	None	None
51	Amreli	6	5	3	1	2

† On the basis of information regarding dates of rust appearance from the College farm
* No slides were exposed during that period in one of the years
‡ No slides were exposed during that period in two of the years

TABLE III—*contd.*

Serial Number	Province and name of station	No. of years during which slides were exposed	No. of years when spore showers took place	No. of years when spores were caught 4 to 2 weeks before rust appearance	No. of years when no spores could be detected 4 to 2 weeks before rust appearance	No. of years when no rust appeared or no information was received regarding rust appearance
	HYDERABAD-DECCAN					
52	Parbhani	6	6	3‡	1	None
53	Himayatsagar ...	6	5	4	2	None
54	Raichur	1	No spores	...	...	1†
	MADRAS					
55	Bellary (Hagari) ...	6	6	3	1	2
56	Coimbatore... ...	6	6	3	1	2
57	Guntur	6	4	2	...	4
58	Koilpatti	1	No spores	...	...	1†
59	Anthiyur	1	1	...	...	1
60	Udumalpet ...	1	1	1	None	None
	MYSORE STATE					
61	Hebbal (Bangalore) ...	6	6	2	...	4
62	Mandya (Mysore) ...	6	6	4	...	2
63§	Hiriyur (Chitaldroog) ...	6	6	4*	1	None

‡ No slides were exposed during that period in two of the years
† There was no crop that year
* No slides were exposed during that period in one of the years
§ The total number of stations was 62. At Poona, two aeroscopes (Nos. 41 and 42) were exposed

TABLE

Study of slides sent up on big balloons (with spore catchers), small balloons and kites at Agra in relation to the appearance of Black Rust *during 1929 to 1938*

Year	Period of kite and balloon flights	Range of height in feet reached by different kites and balloons during the year	Dates on which (*a*) Spores were first caught and (*b*) Spores caught 4 to 2 weeks before rust appearance No. of spores in brackets	Height reached by kites or balloons on dates given in previous column and direction of wind	Duration of exposure of slides	Date of rust appearance
1929-30*	February 11 ... (2 balloons only)	1,500 ft. and 3,000 ft. ...	(*a*) February 11 (2) (*b*) February 11 (2)	1,500 ft.; N.N.W. ... 1,500 ft.; N.N.W.	Nearly 5 min.	March 9
1930-31*	December 16—February 20 (4 balloons only)	1,640 ft. to 4,756 ft. ...	(*a*) December 20 (3) (*b*) January 29 (1)	4,264 ft.; N.N.W. ... 4,756 ft.; W.	6 min. ... 5½ min.	February 22
1931-32*	December 3 ... (1 balloon only)	1,673 ft.	No spores	...	2½ min. ...	February 3rd week
1931-32	December 3—March 14 ...	400 ft. to 4,372 ft. ...	(*a*) January 2 (1) B (*b*) January 29 (45) K	1,485 ft.; E. ... 825 ft.; W.	1¼ h. ... 2 h.	February 3rd week
1932-33	December 12—March 10	654 ft. to 4,088 ft. ...	(*a*) December 14 (2) B (*b*) February 16 (28) K	2,779 ft.; E. & N.E. ... 1,310 ft.; N. & N.W. ...	2¼ h. ... 2 h.	March 5
1933-34	December 15—January 31	450 ft. to 3,300 ft. ...	(*a*) December 21 (1) K (*b*) January 17 (3) K	1,300 ft.; N. & N.W. ... 1,150 ft.; N.W. ...	2½ h. ... 2¼ h.	February 6
1934-35	November 20—March 14	825 ft. to 3,290 ft. ...	(*a*) December 25 (2) B (*b*) January 16 (4) K	1,640 ft.; N. ... 825 ft.; N.W. ...	1¼ h. ... 1¼ h.	February 13
1935-36	November 15—February 29	1,000 ft. to 3,280 ft. ...	(*a*) December 23 (2) B (*b*) February 3 (1) K	2,000 ft.; N.E. ... 1,000 ft.; N.W. ...	1½ h. ... 1 h.	February 22
1936-37	November 17—March 1 ...	1,000 ft. to 2,300 ft. ...	(*a*) January 9 (1) K (*b*) February 5 (1) K	1,300 ft.; N.E. ... 1,500 ft.; E. ...	1½ h. ... 1½ h.	February 24
1937-38	November 15—February 22	800 ft. to 2,000 ft. ...	(*a*) December 20 (1) K (*b*) February 4 (1) K	1,000 ft.; E. ... 1,200 ft.; W. ...	1½ h ... 1½ h.	February 19

* During these years, slides were sent up for preliminary trials on large balloons to which 'spore-catchers' were attached. The 'spore-catcher' is described in Appendix A

B refers to a drum attached to a pair of small balloons and K a kite to which a small balloon was occasionally attached

Map number	Year	Height of the wind in feet above sea level	Date of wind trajectory	Dates of spore shower soon after the wind. Dates of subsequent showers, if any, 14 to 10 days or so before rust appearance within brackets	Date of rust appearance, as reported from the station. Incidence† within brackets	Area or stations where rust had appeared at least 15 days earlier. Date of rust appearance or incidence† within brackets
				PUNJAB		
				Lyallpur (605 feet above sea level)		
2	1932-33 ...	1,640	April 4 ...	No spores	April 20 ...	Hoshiarpur (March, Middle)
	1932-33 ...	3,280	April 4 ...	No spores	April 20 ...	Hoshiarpur (March, Middle)
	1932-33 ...	4,920	April 4 ...	No spores	April 20 ...	Mehsana (February 1st week ; traces) Ajmer (March 11)
				Hoshiarpur (702 feet above sea level)		
3	1934-35 ...	4,920	January 28 ...	January 29—February 1 ... and February 1—4 (February 1—4)	First half of February	Cawnpore (December X'mas week)
				Karnal (900 feet above sea level)		
4	1936-37 ...	1,640	February 26 ...	February 25—March 1§§ ... and March 1—4 (March 1—4)	March 12 ...	Benares (February 18—19 ; traces 10 per cent) Allahabad (February 2)

† Observations made by members of the rust research staff or occasionally the writer. Range of crop infection relates to different fields and on different varieties at that locality

§§ The spore shower might have occurred on February 25, due to some earlier wind

NOTE.—As stated under Methods of study, the date of rust appearance was put back by 3—4 weeks in such cases, where a member of the rust research staff found heavy infection (70 per cent or above) within a week or so of the reported date of first appearance of rust at the station concerned

TABLE V—*contd.*

Map number.	Year	Height of the wind in feet above sea level	Date of wind trajectory	Dates of spore shower soon after the wind. Dates of subsequent showers, if any, 14 to 10 days or so before rust appearance within brackets	Date of rust appearance, as reported from the station. Incidence within brackets	Area or stations where rust had appeared at least 15 days earlier. Date of rust appearance or incidence within brackets
				Karnal (900 feet abovesea level)—*contd.*		
	1936-37 ...	3,280	February 26 ...	February 25—March 1 §§ ... and March 1—4 (March 1—4)	March 12 ...	Jhansi (February 21 ; traces—40 per cent)
	1936-37 ...	4,920	February 26 ...	February 25—March 1 §§ ... and March 1—4 (March 1—4)	March 12 ...	Amreli (December 20) Jagudan (January 29) Mehsana (February 6 ; 0-100 per cent)
				SIND		
				Sakrand (120 feet above sea level)		
5	1936-37 ...	1,640	February 23 ...	February 25—28 ... (February 28—March 1 and March 1—4)	March 13 ...	Central Nepal (December 6 ; nearly 30 per cent)
6	1934-35 ...	3,280	February 11 ...	... (February 21—24) ...	March 4 ... (March 7 ; 5 to 20 per cent)	Cawnpore (December X'mas week) Niphad (January 27)
	1934-35 ...	4,920	February 11 ...	... (February 21—24) ...	March 4 ... (March 7 ; 5 to 20 per cent)	Poona (January 2nd week)

§§ The spore shower might have occurred on February 25, due to some earlier wind

TABLE V—*contd.*

Map number.	Year	Height of the wind in feet above sea level	Date of wind trajectory	Dates of spore shower soon after the wind. Dates of subsequent showers, if any, 14 to 10 days or so before rust appearance within brackets	Date of rust appearance, as reported from the station. Incidence within brackets	Area or stations where rust had appeared at least 15 days earlier. Date of rust appearance or incidence within brackets
				UNITED PROVINCES		
				Agra (554 feet above sea level)		
7	1936-37 ...	1,640	February 5 ...	February 6—9 (February 9—12) ...	February 24 ...	Gorakhpur (January 5—6; traces) Fyzabad (December 4th week)
	1936-37 ...	3,280	February 5 ...	February 6—9, 9—12 (February 9—12) ...	February 24 ...	Central Nepal (December 6; nearly 30 per cent)
8	1936-37 ...	4,920	February 6 ...	February 6—9, 9—12 (February 9—12) ...	February 24 ...	Niphad (December 3)
9	1937-38 ...	6,560	January 31 ...	... ...	February 19 ...	Niphad (January 2)
				Gorakhpur (257 feet above sea level)		
10	1936-37 ...	1,640	December 14 ...	... (December 23—26) ...	No information ... (January 5—6; traces)	Central Nepal (December 6; nearly 30 per cent)
11	1936-37 ...	3,280	December 16 ...	December 17—20* (December 23—26) ...	No information ... (January 5—6; traces)	Central Nepal (December 6; nearly 30 per cent)
12	1936-37 ...	4,920	December 15 ...	December 17—20* (December 23—26) ...	No information ... (January 5—6; traces)	Central Nepal (December 6; nearly 30 per cent)
13	1936-37 ...	6,560	December 13 ...	December 17—20 ... (December 23—26) ...	No information ... (January 5—6; traces)	Central Nepal (December 6; nearly 30 per cent)

wind rel ... o in the previo column been included ... hose ... d by spore showers in Table VI bu ... d with a query

TABLE 'ontd

Map Number	Year	Height of the wind in feet above sea level	Date of wind trajectory	Dates of spore shower soon after the wind. Dates of subsequent showers, if any, 14 to 10 days or so before rust appearance within brackets	Date of rust appearance, as reported from the station. Incidence within brackets	Area or stations where rust had appeared at least 15 days earlier. Date of rust appearance or incidence within brackets
				BIHAR		
				Pusa (188 feet above sea level)		
14	1934-35 ...	1,640	January 7 ...	January 7—10 and 10—14 ... (January 21—24)	January 31 ...	Central Nepal (December 23 ; 10-20 per cent)
	1934-35 ...	3,280	January 7 ...	January 7—10 and 10—14 ... (January 21—24)	January 31 ...	Central Nepal (December 23 ; 10-20 per cent)
	1934-35 ...	4,920	January 7 ...	January 10—14 ... ... (January 21—24)	January 31 ...	Central Nepal (December 23 ; 10-20 per cent)
	1934-35 ...	6,560	January 7 ...	January 10—14* ... ... (January 21—24)	January 31 ...	Central Nepal (December 23 ; 10-20 per cent)
15	1936-37 ...	1,640	January 23 ...	January 22—26 and** ... January 26—29 (January 29—February 2)	February 11 ...	Gorakhpur (January 5—6 ; traces)
	1936-37 ...	3,280	January 23 ...	January 22—26 and** ... January 26—29 (January 29—February 2)	February 11 ...	Gorakhpur (January 5—6 ; traces)
	1936-37 ...	4,920	January 23 ...	January 26—29 ... ... (January 29—February 2)	February 11 ...	Gorakhpur (January 5—6 ; traces)
	1936-37 ...	6,560	January 23 ...	January 26—29 ... ... (January 29—February 2)	February 11 ...	Gorakhpur (January 5—6 ; traces)

Tl nd referred to previous column ha: bee included in the list of th 'ollo
Tl ›re shower mi ›e occurred on Janu: 22, due to some earlier wind

TABLE V—*contd.*

Map Number	Year	Height of the wind in feet above sea level	Date of wind trajectory	Dates of spore shower soon after the wind. Dates of subsequent showers, if any, 14 to 10 days or so before rust appearance within brackets	Date of rust appearance, as reported from the station. Incidence within brackets	Area or stations where rust had appeared at least 15 days earlier. Date of rust appearance or incidence within brackets
				Sabour (122 feet above sea level)		
16	1932-33 ...	1,640	February 15 ...	February 16—19 ... (February 16—19) ...	March 1st week ...	Gorakhpur (January 10)
17	1934-35 ...	3,280	February 14 ...	February 14—18, 18—21 (February 25—28) ...	March 8 ...	Central Nepal (December 23; 10-20 per cent) Gonda (January 27); Gorakhpur (January 28) and Patna (January 4th week)
	1934-35 ...	4,920	February 14 ...	February 14—18, 18—21 (February 25—28) ...	March 8 ...	Central Nepal (December 23; 10-20 per cent) Gonda (January 27)
	1934-35 ...	6,560	February 14 ...	February 18—21 (February 25—28) ...	March 8 ...	Central Nepal (December 23; 10-20 per cent)
				BENGAL		
				Mymensingh (62 feet above sea level)		
18	1936-37 ...	1,640	January 8 ...	Slides were not exposed ...	Did not appear (February 15; traces—3 per cent)	Central Nepal (December 6; nearly 30 per cent)
19	1936-37 ...	3,280	January 20 ...	Slides were not exposed ...	Did not appear (February 15; traces—3 per cent)	Central Nepal (December 6; nearly 30 per cent) Gorakhpur (January 5—6; traces)

TABLE ontd

Map Number	Year	Height of the wind in feet above sea level	Date of wind trajectory	Dates of spore shower soon after the wind. Dates of subsequent showers, if any, 14 to 10 days or so before rust appearance within brackets	Date of rust appearance, as reported from the station. Incidence within brackets	Area or stations where rust had appeared at least 15 days earlier. Date of rust appearance or incidence within brackets
				(Mymensingh (62 feet above sea level)—*contd.*		
20	1936-37 ...	4,920	January 19 ...	Slides were not exposed ...	Did not appear (February 15; traces—3 per cent)	Central Nepal (December 6; nearly 30 per cent)
19	1936-37 ...	6,560	January 20 ...	Slides were not exposed ...	Did not appear (February 15; traces—3 per cent)	Central Nepal (December 6; nearly 30 per cent)
				ASSAM		
				Dhubri (115 feet above sea level)		
21	1936-37 ...	4,920	December 16 ...	Slides were not exposed ...	No information ... (January 23; 1—25 per cent)	Central Nepal (December 6; nearly 30 per cent)
	1936-37 ...	6,560	December 16 ...	Slides were not exposed ...	No information ... (January 23; 1—25 per cent)	Central Nepal (December 6; nearly 30 per cent)

TABLE V—*con.*

Map Number	Year	Height of the wind in feet above sea level	Date of wind trajectory	Dates of spore shower soon after the wind. Dates of subsequent showers, if any, 14 to 10 days or so before rust appearance within brackets	Date of rust appearance, as reported from the station. Incidence within brackets	Area or stations where rust had appeared at least 15 days earlier. Date of rust appearance or incidence within brackets
				CENTRAL PROVINCES		
				Jubbulpore (1,289 feet above sea level)		
22	1934-35 ...	1,640	January 28 ...	January 27—31** ... (January 31—February 3 and February 3—7)	February 17 ...	Pottangi (January 8—9; 1 per cent)
23	1934-35 ...	3,280	January 27 ...	January 27—31 ... ... (January 31—February 3 and February 3—7)	February 17 ...	Pottangi (January 8—9; 1 per cent)
24	1935-36 ...	4,920	January 23 ...	January 25—29 ... ... (February 1—4)	February 27 ... (February Middle; traces)	Mahableshwar (January 5; moderate) Poona (December 23)
	1935-36 ...	6,560	January 23 ...	January 25—29* ... ... (February 1—4)	February 27 ... (February Middle; traces)	Poona (December 23)
				Khandwa (1,044 feet above sea level)		
25	1933-34 ...	1,640	January 2 ...	January 2—6; 6—9 ... (January 16—20)	January 30 ...	Bellary (December 11; 10-40 per cent)
26	1933-34 ...	3,280	January 10 ...	*January 9—13†† (January 16—20)	January 30 ...	Pottangi (January 13—14; 100 per cent)
27	1933-34 ...	4,920	January 4 ...	January 6—9; 9—13 ... (January 16—20)	January 30 ...	Bellary (December 11; 10-40 per cent)
	1933-34 ...	6,560	January 4 ...	January 6—9; 9—13 ... (January 16—20)	January 30 ...	Bellary (December 11; 10-40 per cent)

** The spore shower might have occurred on January 27, due to some earlier wind

* The wind referred to in the previous column has been included in the list of those followed by spore showers in Table VI but marked with a query

†† The spore shower might have occurred on January 9, due to some earlier wind

TABLE V *ontd*

Map Number	Year	Height of the wind in feet above sea level	Date of wind trajectory	Dates of spore shower soon after the wind. Dates of subsequent showers, if any, 14 to 10 days or so before rust appearance within brackets	Date of rust appearance, as reported from the station. Incidence within brackets	Area or stations where rust had appeared at least 15 days earlier. Date of rust appearance or incidence within brackets
				BOMBAY-DECCAN		
				Poona (1,834 feet above sea level)		
28	1935-36 ...	3,280	November 29 ...	November 28—December 2 and‡ December 2—5 (December 9—12)	December 23 ...	Bellary (November 14) Chitaldroog (October 22 ; 5 per cent) on early crop sown in August
				Dharwar (2,340 feet above sea level)		
29	1935-36 ...	3,280	December 29 ...	December 29—January 2 and January 2—6 (January 2—6)	January 15 ...	Chitaldroog (October 22 ; 5 per cent)
	1935-36 ...	4,920	December 29 ...	December 29—January 2 and January 2—6 (January 2—6)	January 15 ...	Bellary (November 14)
30	1934-35 ...	6,560	December 6 ...	December 7—11 ; 11—15 ... (December 11—15)	December 28 ...	Chitaldroog (November 29-30 ; 1-50 per cent)
31	1935-36 ...	9,840	December 24 ...	December 29—January 2 ... (January 2—6)	January 15 ...	Chitaldroog (October 22 ; 5 per cent)
				HYDERABAD-DECCAN		
				Parbhani (1,350 feet above sea level)		
32	1935-36 ...	3,280	January 6 ...	... (January 10—14)	January 23 ...	Bellary (November 14) and Hyderabad (December 9)
33	1935-36 ...	4,920	December 24 ...	... (January 10—14) ...	January 23 ...	Hyderabad (December 9)

‡ The spore shower might have occurred on November 28, due to some earlier wind

TABLE V—*contd*

Map Number	Year	Height of the wind in feet above sea level	Date of wind trajectory	Dates of spore shower soon after the wind. Dates of subsequent showers, if any, 14 to 10 days or so before rust appearance within brackets	Date of rust appearance, as reported from the station. Incidence within brackets	Area or stations where rust had appeared at least 15 days earlier. Date of rust appearance or incidence within brackets
			Himayatsagar near Hyderabad (1,776 feet above sea level)			
34	1936-37 ...	4,920	January 19 ...	January 21—24 (January 24—28) ...	February 8 ...	Parbhani (January 3)
35	1936-37 ...	6,560	January 17 ...	January 21—24 ... (January 24—28) ...	February 8 ...	Niphad (December 3)
			MADRAS			
			Coimbatore (1,341 feet above sea level)			
36	1936-37 ...	1,640	January 29 ...	January 29—February 2 and February 2—6 (February 6—11)	February 18 ...	Nilgiris (October 1 ; 0-25 per cent)
37	1936-37 ...	3,280	January 31 ...	February 2—6 ... (February 6—11) ...	February 18 ...	Kodaikanal (October 10 ; traces)
	1936-37 ...	4,920	January 31 ...	February 2—6 ... (February 6—11) ...	February 18	Kodaikanal (October 10 ; traces)
	1936-37 ...	6,560	January 31 ...	February 2—6 ; 6—11 (February 6—11) ...	February 18 ...	Kodaikanal (October 10 ; traces)
38	1933-34 ...	4,920	January 12 ...	...	February 3 ...	Nilgiris (December 24 ; 100 per cent)

TAB] :ontd

Map Number	Year	Height of the wind in feet above sea level	Date of wind trajectory	Dates of spore shower soon after the wind. Dates of subsequent showers, if any, 14 to 10 days or so before rust appearance within brackets	Date of rust appearance, as reported from the station. Incidence within brackets	Area or stations where rust had appeared at least 15 days earlier. Date of rust appearance or incidence within brackets
				MYSORE STATE		
				Bangalore (3,021 feet above	**sea level)**	
39	1933-34 ...	6,560	November 18	November 19—23* ... (......)	December 18 ... (December 18; 5-10 per cent in miniature plot)	Nilgiris (December 24; 100 per cent)
				Mandya (Mysore) (2,580 feet	**above sea level)**	
40	1937-38 ...	3,280	December 22 ...	December 30—January 3** ...	January 21 ...	Nilgiris (December 19; 0-100 per cent)
41	1935-36 ...	4,920	September 29 ...	September 30—October 3 ... (September 30—October 3)	October 16 ...	Kodaikanal (September 28; 0-20 per cent)
42	1933-34 ...	6,560	November 18 ...	... ... (December 4—7)	December 19 ... (December 19; 10 per cent)	Nilgiris (December 24; 100 per cent)
43	1935-36 ...	9,840	September 14 ...	September 19—23; 23—26, 26—30 (September 30—October 3)	October 16 ...	Nilgiris (September 20; 65-100 per cent)
	1935-36 ...	13,120	September 14 ...	September 19—23, 23—26; 26—30 (September 30—October 3)	October 16	Nilgiris (September 20; 65-100 per cent)

TABLE con

Map Number	Year	Height of the wind in feet above sea level	Date of wind trajectory	Dates of spore shower soon after the wind. Dates of subsequent showers, if any, 14 to 10 days or so before rust appearance within brackets	Date of rust appearance, as reported from the station. Incidence within brackets	Area or stations where rust had appeared at least 15 days earlier. Date of rust appearance or incidence within brackets
				Chitaldroog (2,405 feet above sea level)		
44	1936-37 ...	3,280	November 10 ...	... (November 17—21 and 21—24)	No information ... (January 2—3; 25-100 per cent) ‡	Nilgiris (October 1; 0-25 per cent)
45	1936-37 ...	4,920	November 13 ...	... (November 17—21 and 21—24)	No information ... (January 2—3; 25-100 per cent)‡	Nilgiris (October 1; 0-25 per cent)
46	1936-37 ...	6,560	November 9 ...	... ... (November 17—21 and 21—24)	No information ... (January 2—3; 25-100 per cent)‡	Nilgiris (October 1; 0-25 per cent)

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TABLE VI

Su ary of data of 4966 'nd-trajectories studied for the dissemination **Black us** *du 'g 1932 to 38*

Year	Date of rust appearance, as reported from the station. Incidence* where known within brackets	Dates of spore shower, if any, nearly 4 to 2 weeks before rust appearance; those only 14 to 10 days or so earlier in brackets	Period of wind trajectories	Number of winds					Number of relevant winds followed by spore showers	Stations of earlier rust appearance passed over by relevant winds. Ref. Tables II and V	Total number of possibly‡ relevant winds, i.e., from the hills. Those followed by spore showers within brackets
				Studied	Found to be relevant†						
					a	b	c	d			
			PUNJAB								
			1. Lyallpur								
1932-33	April 20 ...	April 1—4	March 20 to April 5 ...	56	1	0	0	2	0	Hoshiarpur, Ajmer, Mehsans	15 (5+2?)
1933-34	March 1st week ...	No spores ...	February 1—15 ...	59	0	0	1	0	0	Patna	1
1934-35	March 20 ...	February 18—21 ...	February 20 to March 5	54	0	0	0	0	0	...	17
1935-36	March 25 ...	February 25—29 ...	February 25 to March 12	54	0	0	0	2	0+1?	Hoshiarpur	7 (0+2?)
1936-37	March 20 ...	March 1—4 (March 8—11) ...	February 20 to March 7	54	0	0	0	0	...	...	16 (12+3?)
1937-38	April 1 ...	March 14—17 (March 21—24) ...	March 1—16 ...	54	0	0	0	0	...	...	8 (1+2?)

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TABLE VI—*contd.*

Year	Date of rust appearance, as reported from the station. Incidence where known within brackets	Dates of spore shower, if any, nearly 4 to 2 weeks before rust appearance ; those only 14 to 10 days or so earlier in brackets	Period of wind trajectories	Number of winds: Studied	Found to be relevant: a	b	c	d	Number of relevant winds followed by spore showers	Stations of earlier rust appearance passed over by relevant winds. Ref. Tables II and V	Total number of possibly relevant winds, i.e., from the hills. Those followed by spore showers within brackets
			2. Hoshiarpur**								
1932-33	Middle of March ...	February 17—21 ...	February 15 to March 1	56	0	0	0	0	...	...	27 (4+6 ?)
1933-34	February 1st week	No spores	January 1—15 ...	57	0	0	0	0	...	...	27
1934-35	February 1st half ...	January 14—17 ; ... January 29 to February 1 (February 1—4)	January 1—31 ...	119	0	1	0	0	1	Cawnpore ...	44 (39+2 ?)
			3. Rawalpindi**								
1933-34	April 19 ...	April 1—5 ... (April 5—8)	March 19 to April 2 ...	45	0	0	0	0	...	...	7 (5+1 ?)
1934-35	March 3rd week ...	February 25 to March 1 (March 5—8)	February 15 to March 5	57	0	0	0	0	...	...	5 (4)
			4. Karnal								
1933-34	March 2 ...	February 7—11 ...	February 2—16 ...	57	0	2	0	0	0	Gonda,* Gorakhpur	8 (4)
1934-35	March 4 ...	February 11—14 ...	February 4—17 ...	55	1	1	0	0	0	Cawnpore, Parbhani	22 (5+6 ?)

**—situated at foot-hills

? Represents number of winds followed by spore showers during the periods not strictly in accordance with the heights of the winds concerned. Ref. sub-head 10 *(ii)*

* At this station rust was found in traces on January 3

TAB contd.

Year	Date of rust appearance, as reported from the station. Incidence where known within brackets	Dates of spore shower, if any, nearly 4 to 2 weeks before rust appearance; those only 14 to 10 days or so earlier in brackets	Period of wind trajectories	Number of winds: Studied	Found to be relevant: a	b	c	d	Number of relevant winds followed by spore showers	Stations of earlier rust appearance passed over by relevant winds. Ref. Tables II and V	Total number of possibly relevant winds, i.e., from the hills. Those followed by spore showers within brackets
			4. Karnal—*contd.*								
1935-36	February 27 ...	February 3—6 ... (February 13—17)	January 27 to February 10	40	1	0	0	0	0	Hyderabad (Deccan)	15 (11+2?)
1936-37	March 12 ...	February 22—25; ... Febuary 25 to March 1 (March 1—4)	February 12—27 ...	55	1	2	1	2	5	Amreli, Fyzabad, Allahabad, Benares, Jhansi, Jagudan, Mehsana	15 (9)
1937-38	March 10 ...	February 10—14 ... (February 28—March 3)	February 7—23 ...	63	0	0	0	0	...	...	28 (4+5?)
			SIND								
			5. Sakrand								
1933-34	March 17 ...	No spores ... (March 6—9)	February 17 to March 3	60	0	0	0	0	...	...	0
1934-35	March 4 ... (March 7; 10—20 per cent)	February 3—6 ... (February 21—24)	February 4—17 ...	56	0	1	1	0	0	Cawnpore, Niphad, Poona	0

TABLE V [illegible]d

Year	Date of rust appearance, as reported from the station. Incidence where known within brackets	Dates of spore shower, if any, nearly 4 to 2 weeks before rust appearance; those only 14 to 10 days or so earlier in brackets	Period of wind trajectories	Number of winds: Studied	Found to be relevant: a	b	c	d	Number of relevant winds followed by spore showers	Stations of earlier rust appearance passed over by relevant winds. Ref. Tables II and V	Total number of possibly relevant winds, i.e., from the hills. Those followed by spore showers within brackets
			5. Sakrand—*contd*								
1935-36	February 28 ...	February 4—7 ...	January 28 to February 11	36	0	0	0	0	...	...	1
1936-37	March 13 ...	February 13—16; February 25—28 (March 1—4)	February 13—28 ...	50	1	0	0	0	1	Central Nepal	0
1937-38	March 20 ...	March 1—3; March 5—7 (March 9—11)	February 17 to March 5	53	0	0	0	0	...	...	2
			DELHI								
			6. Delhi								
1937-38	March 17 ...	February 26 to March 2 (March 2—5)	February 15 to March 2	64	0	0	0	0	...	...	16 (7+7?)

E VI—*contd*

Year	Date of rust appearance, as reported from the station. Incidence where known within brackets	Dates of spore shower, if any, nearly 4 to 2 weeks before rust appearance; those only 14 to 10 days or so earlier in brackets	Period of wind trajectories	Number of winds: Studied	Found to be relevant: a	b	c	d	Number of relevant winds followed by spore showers	Stations of earlier rust appearance passed over by relevant winds. Ref. Tables II and V	Total number of possibly relevant winds, i.e., from the hills. Those followed by spore showers within brackets
			UNITED PROVINCES								
			7. Agra								
1932-33	March 5 ...	February 14—18 ...	February 4—19 ...	63	1	0	0	0	0+1 ?	Amreli ...	21 (1+6 ?)
1933-34	February 6 ...	January 14—21 ...	January 6—20 ...	55	0	0	0	0	...	...	8 (2+4 ?)
1934-35	February 13 ...	January 27—30 ...	January 13—29 ...	66	0	1	1	0	1	Cawnpore, ... Central Nepal	11 (2+1 ?)
1935-36	February 22 ...	January 26—28 ...	January 22 to February 5	62	0	1	0	0	1	Niphad ...	11 (1+2 ?)
1936-37	February 24 ...	February 6—9 (February 9—12) ...	January 24 to February 8	64	6	2	0	0	8	Central Nepal, Gorakhpur, Fyzabad, Amreli, Niphad	10(10)
937-38	February 19 ...	January 27—30 ...	January 19 to February 3	57	0	1	0	0	0	Niphad ...	7 (0+2 ?)

TABLE

Year	Date of rust appearance, as reported from the station. Incidence where known within brackets	Dates of spore shower, if any, nearly 4 to 2 weeks before rust appearance; those only 14 to 10 days or so earlier in brackets	Period of wind trajectories	Number of winds					Number of relevant winds followed by spore showers	Stations of earlier rust appearance passed over by relevant winds. Ref. Tables II and V	Total number of possibly relevant winds, i.e., from the hills. Those followed by spore showers within brackets
				Studied	Found to be relevant						
					a	b	c	d			
			8. Gorakhpur**								
1933-34	February 1st or 2 2nd week ‡ (January 15; 20 per- cent)	December 13—16; ... December 30 to January 4	December 15—29 ...	60	0	0	0	0	...	...	38 (5+4 ?)
1934-35	January 28 ...	No spores	December 28 to January 12	64	0	0	0	13† 1	0	Central Nepal Cawnpore	12
1935-36	January 15 ...	December 29 to January 2	December 15—29 ...	58	0	0	0	0	...	...	30 (11+5 ?)
1936-37	No information ... (January 5—6; traces)	December 17—20 ... (December 23—26)	December 6—21 ...	50	0	0	0	10*	1+2 ?	Central Nepal	16 (1+4 ?)
1937-38	February 20 ...	January 31 to February 2 (February 7—10)	January 20 to February 5	57	0	0	0	0	...	...	24 (2+12 ?)

** Situated at fc hills
‡ The informa ı received stated rusts were found in t rst and second week of Febru No
†In central Ne 10 to 20 per cent crop infection wa: erved on December 23, 1934
*In central Nı l nearly 30 per cent crop infection wa: ıerved on December 6, 1936

TAB

Year	Date of rust appearance, as reported from the station. Incidence where known within brackets	Dates of spore shower, if any, nearly 4 to 2 weeks before rust appearance; those only 14 to 10 days or so earlier in brackets	Period of wind trajectories	Number of winds: Studied	Found to be relevant: a	b	c	d	Number of relevant wind followed by spore showers	Stations of earlier rust appearance passed over by relevant winds. Ref. Tables II and V	Total number of possibly relevant winds, i.e., from the hills. Those followed by spore showers within brackets
			BIHAR								
			9. Pusa								
1932-33	February 13 ...	No spores	January 14—29 ...	64	0	0	0	8	0	Gorakhpur ...	11
1933-34	February 7 ...	January 18—22 ... (January 22—25)	January 7—21 ...	57	0	0	0	3	2+1 ?	Gonda ...	20 (10+2 ?)
1934-35	January 31 ...	January 10—14 ...	January 1—16 ...	63	0	0	0	23*	15+6 ?	Central Nepal	3 (0+3 ?)
1935-36	February 9 ...	January 14—17 ...	January 9—23 ...	59	0	0	1	0	0	Niphad ...	22 (2+4 ?)
1936-37	February 11 ...	January 22—26; January 26—29 January 29—February 2	January 11—26 ...	63	0	13	7	15	21+2 ?	Central Nepal, Fyzabad, Gorakhpur	2
1937-38	March 3 ...	February 10—14 ... (February 17—21)	February 1—16 ...	39	0	0	0	0	...	...	17 (8+6 ?)
			10. Sabour								
1932-33	March 1st week ...	February 12—16 ... (February 16—19)	February 1—15 ...	56	0	3	9	0	5+2 ?	Gorakhpur	14 (5+7 ?)
1933-34	March 8 ...	February 18—22 ... (February 22—25)	February 8—22 ...	53	0	9	0	1	7	Gorakhpur, Pusa, Shahjahanpur	9 (5+3 ?)

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TA: VI—*contd.*

Year	Date of rust appearance, as reported from the station. Incidence where known within brackets	Dates of spore shower, if any, nearly 4 to 2 weeks before rust appearance; those only 14 to 10 days or so earlier in brackets	Period of wind trajectories	Number of winds: Studied	Found to be relevant: a	b	c	d	Number of relevant winds followed by spore showers	Stations of earlier rust appearance passed over by relevant winds. Ref. Tables II and V	Total number of possibly relevant winds, i.e., from the hills. Those followed by spore showers within brackets
			10 Sabour—*contd.*								
1934-35	March 8 ...	February 18—21 ... (February 25—28)	February 8—21 ...	52	14	12	3	6	15+9?	Central Nepal, Fyzabad, Patna, Gonda, Gorakhpur, Cawnpore, Pusa, Benares	0
1937-38	February end of 2nd week	No spores	January 15—31 ...	57	0	0	0	0	...	...	31
			BENGAL								
			11. Mymensingh								
1936-37	Did not appear ... (February 15; traces—3 per cent)	*	January 5—20 ...	63	0	16	0	0	*	Central Nepal, Gorakhpur, Fyzabad	0
1937-38	No information ... (February 27; 1-10 per cent)	*	January 12—27 ...	52	0	0	0	0	*	...	5

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Year	Date of rust appearance, as reported from the station. Incidence where known within brackets	Dates of spore shower, if any, nearly 4 to 2 weeks before rust appearance; those only 14 to 10 days or so earlier in brackets	Period of wind trajectories	Number of winds: Studied	Found to be relevant: a	b	c	d	Number of relevant winds followed by spore showers	Stations of earlier rust appearance passed over by relevant winds. Ref. Tables II and V	Total number of possibly relevant winds, i.e., from the hills. Those followed by spore showers within brackets
			ASSAM								
			12. Dhubri**								
1936-37	No information ... (January 23; 1-25 per cent)	*	December 2—20 ...	62	0	0	0	6	*	Central Nepal	2
1937-38	No information ... (February 25; 0-2 per cent)	*	January 20 to February 10	70	0	0	0	0	*	...	5
			CENTRAL PROVINCES								
			13. Jubbulpore								
1932-33	February 25 ...	No spores ... ... (February 11—15)	January 26 to February 10	64	1	1	3	1	0	Gorakhpur, Niphad	7 (1)
1933-34	January 28 ...	January 6—10 ... (January 17—20)	December 28 to January 13	61	0	3	0	1	1+1?	Pottangi, Chitaldroog, Dharwar	3 (1+2?)
1934-35	February 17 ...	January 31 to February 3 (February 3—7)	January 17 to February 1	57	0	3	1	9	13	Central Nepal, Cawnpore, Pottangi, Poona, Hyderabad (Deccan)‡	0

* No slides were exposed at this station
** Situated at foot-hills
‡ At this station rust was found in traces on November 23

TA

Year	Date of rust appearance as reported from the station. Incidence where known within brackets	Dates of spore shower, if any, nearly 4 to 2 weeks before rust appearance ; those only 14 to 10 days or so earlier in brackets	Period of wind trajectories	Number of winds: Studied	Found to be relevant: a	b	c	d	Number of relevant winds followed by spore showers	Stations of earlier rust appearance passed over by relevant winds. Ref. Tables II and V	Total number of possibly relevant winds, i.e., from the hills. Those followed by spore showers within brackets
			13. Jubbulpore—*contd.*								
1935-36	February 27 ... (Middle of February traces)	January 25—29 ... (February 1—4)	January 10—31 ...	86	1	8	0	0	8+1 ?	Pottangi, Niphad, Mahableshwar, Poona, Bellary, Hyderabad (Deccan)	11 (8+3 ?)
1936-37	End of January ...	January 9—13 ...	December 25 to January 16	92	0	3	2	5	3+1 ?	Central Nepal, Niphad, Ahmedabad,‡ Amreli, Mahableshwar,† Poona	18 (5+5 ?)
1937-38	February 14 ...	*	January 14—29 ...	56	0	0	0	1	0	Niphad	0
			14. Khandwa								
1933-34	January 30 ...	January 9—13 ... (January 16—20)	December 30 to January 13	47	0	6	3	0	6+3 ?	Pottangi, Bellary	0

* Slides were not exposed after January 19

‡ At this station up to 65 per cent crop infection was observed on January 19-20

† Rust was found in traces on December 25—27 in this area

TABLE VI—*contd*.

Year	Date of rust appearance, as reported from the station. Incidence where known within brackets	Dates of spore shower, if any, nearly 4 to 2 weeks before rust appearance; those only 14 to 10 days or so earlier in brackets	Period of wind trajectories	Number of winds: Studied	Found to be relevant: a	b	c	d	Number of relevant winds followed by spore showers	Stations of earlier rust appearance passed over by relevant winds. Ref. Tables II and V	Total number of possibly relevant winds, i.e, from the hills. Those followed by spore showers within brackets
			ORISSA								
		15.	**Pottangi (Jeypore Agency area)**								
1935-36	(November 23—28; traces)	**	November 1—15 ...	58	0	0	0	0	...	...	0
1937-38	(January 12; traces)	**	December 12—31 ...	57	0	0	0	0	...	...	0
			BOMBAY-DECCAN								
			16. (†) Poona‡								
1932-33	December 5 ...	No spores (November 24—28) ...	November 5—20 ...	45	0	0	0	0	...	...	0
1933-34	January 1st week ...	December 4—7 ...	December 1—15 ...	42	0	0	0	0	...	...	0
1934-35	January 2nd week ...	December 17—20 (December 27—31) ...	December 8—23 ...	48	0	0	0	0	...	...	0
1935-36	December 23 ...	December 5—9 (December 9—12) ...	November 23 to December 7	44	0	1	0	0	1	Bellary, Chitaldroog	0
1936-37	December 14 ...	November 26—30 ... (November 30 to December 3)	November 14—29 ...	48	0	0	0	0	...	...	0

** No slides were exposed at this station
(†) Winds that might be taken as 'possibly relevant' for this station have been referred to in the text
‡ Situated at foot-hills

Year	Date of rust appearance, as reported from the station. Incidence where known within brackets	Dates of spore shower, if any, nearly 4 to 2 weeks before rust appearance; those only 14 to 10 days or so earlier in brackets	Period of wind trajectories	Number of winds: Studied	Number of winds: Found to be relevant a	b	c	d	Number of relevant winds followed by spore showers	Stations of earlier rust appearance passed over by relevant winds. Ref. Tables II and V	Total number of possibly relevant winds, i.e., from the hills. Those followed by spore showers within brackets
			17. Dharwar								
1932-33	January 17 ...	(*)	December 20 to January 3	28	2	2	0	0	(*)	Chitaldroog, Ootacamund	0
1933-34	November 21 ...	October 27—30 ...	October 21 to November 4	45	0	0	0	0	...	...	0
1934-35	December 28 ...	December 4—7 ... (December 11—15)	November 28 to December 13	48	0	0	3	3	3+3 ?	Chitaldroog	0
1935-36	January 15 ...	December 25—29; December 29 to January 2 (January 2—6)	December 15—31 ...	55	12	28	0	0	40	Bellary, Chitaldroog	0
1936-37	December 1	November 23—26 ... (November 26—30)	November 10—25 ...	44	0	0	0	0	...	...	0
1937-38	January 5 ...	December 14—17 ... (December 21—24)	December 5—20 ...	44	0	0	0	3	2+1 ?	Chitaldroog	0

TABLE

Year	Date of rust appearance as, reported from the station. Incidence where known within brackets	Dates of spore shower, if any, nearly 4 to 2 weeks before rust appearance; those only 14 to 10 days or so earlier in brackets	Period of wind trajectories	Number of winds: Studied	Found to be relevant: a	b	c	d	Number of relevant winds followed by spore showers	Stations of earlier rust appearance passed over by relevant winds. Ref. Tables II and V	Total number of possibly relevant winds, i.e., from the hills. Those followed by spore showers within brackets
			HYDERABAD-DECCAN 18. Parbhani								
1935-36	January 23 ...	January 10—14 ...	December 23 to January 6	40	0	3	1	7	...	Pottangi, Hyderabad, Bellary, Arbhavi	0
1936-37	January 3 ... (January 1; traces)	‡	December 3—18 ...	43	0	0	0	0	...	...	0
1937-38	January 14 ...	December 27—30 ...	December 14—29 ...	41	0	0	0	0	...	...	0
			19. Himayatsagar * near Hyderabad								
1933-34	Middle of January (January 20—21; 5-100 per cent)	December 17—22; ... November 30 to December 7	November 20 to December 5	48	0	0	0	0	...	...	0
1934-35	January 15 ... (January 19; 1-100 per cent)	December 5—16; ... November 22—26 (December 5—9)	November 19 to December 10	66	0	0	0	0	...	...	0
1935-36	December 9 ...	November 19—22 ... (November 26—30)	November 9—23 ...	54	0	0	0	0	...	...	0
1936-37	February 8 ...	January 21—24 ... (January 24—28)	January 8—23 ...	48	0	1	0	2	3	Parbhani, Broach, Niphad	0

Slid were not exposed before December 25, 193
Wir ; that might be taken as ' possibly relevant ' tatio red

TABLE con:

Year	Date of rust appearance, as reported from the station. Incidence where known within brackets	Dates of spore shower, if any, nearly 4 to 2 weeks before rust appearance; those only 14 to 10 days or so earlier in brackets	Period of wind trajectories	Number of winds					Number of relevant winds followed by spore showers	Stations of earlier rust appearance passed over by relevant winds. Ref. Tables II and V	Total number of possibly relevant winds, i.e., from the hills. Those followed by spore showers within brackets
				Studied	Found to be relevant						
					a	b	c	d			
			MADRAS								
			20. Coimbatore**								
1933-34	February 3 ...	January 8—11 ...	January 3—17 ...	60	0	13	0	0	1+3 ?	Nilgiris, (Ootacamund, Coonoor)	0
1936-37	February 18	January 29 to February 2 (February 2—6, 6—11)	January 18 to February 2	63	8	0	0	0	8	Nilgiris, Kodaikanal	0
1937-38	September 10	No spores ... ... August 31 to September 3	August 10—31 ...	85	0	3	0	0	1+1 ?	Ootacamund	0
			MYSORE								
			21. Bangalore								
1933-34	December 18 ... (December 18; 5—10 per cent)	November 19—23 ...	November 10—25 ...	63	0	0	0	1	0+1 ?	Ootacamund (Nilgiris)	0

foot

TABLE VI—*contd.*

Year	Date of rust appearance, as reported from the station. Incidence where known within brackets	Dates of spore shower, if any, nearly 4 to 2 weeks before rust appearance; those only 14 to 10 days or so earlier in brackets	Period of wind trajectories	Number of winds: Studied	Found to be relevant: a	b	c	d	Number of relevant winds followed by spore showers	Stations of earlier rust appearance passed over by relevant winds. Ref. Tables II and V	Total number of possibly relevant wnds, i.e., from the hills. Those followed by spore showers within brackets
			22. Mandya (Mysore)								
1933-34	December 19 ... (December 19; 10 per cent)	December 4—7 - ...	November 10—25 ...	65+1†	0	0	0	3+1†	0	Ootacamund (Nilgiris)	0
1934-35	November 10	October 18—22 ... (October 29—November 1)	October 10—25 ...	47	0	0	0	0	...	...	2
1935-36	October 16 ...	September 30 to October 3	September 10—30 ...	82+8†	0	0	0	8 1	1+7†	Kodaikanal, Nilgiris	0
1937-38	January 21 ...	December 30 to January 3	December 21 to January 5	45	1	0	0	0	0+1 ?	Nilgiris	0
			23. Chitaldroog**								
1932-33	End of November ...	No spores	November 1—15 ...	39	0	0	1	0	0	Ootacamund (Nilgiris)	0
1933-34	January 12 ... (December 15; over 60 per cent)	December 9—12; ... October 31 to November 3	November 1—16 ...	48	0	0	0	0	...	...	0
1934-35	No rust ... (November 29—30; 1-50 per cent)(*)	(-)	September 29 to October 14	48	0	0	0	0	...	...	0

† Cloud observations
** Situated at foot-hills
(*) Plenty of teleuto-material at the time of observation, hence the date of rust appearance was put back by a month
(-) Slides were not exposed after July 16 till February 5

TABLE 'd.

Year	Date of rust appearance, as reported from the station. Incidence where known within brackets	Dates of spore shower, if any, nearly 4 to 2 weeks before rust appearance; those only 14 to 10 days or so earlier in brackets	Period of wind trajectories	Number of winds					Number of relevant winds followed by spore showers	Stations of earlier rust appearance passed over by relevant winds. Ref. Tables II and V	Total number of possibly relevant winds, i.e., from the hills. Those followed by spore showers within brackets
				Studied	Found to be relevant						
					a	b	c	d			
			23. Chitaldroog **—*contd.*								
1935-36	January 1 ... (October 22; 5 per cent)	September 30 to October 3	September 10—30 ...	82	0	0	0	0	...	...	0
1936-37	No information ... (January 2—3; 25—100 per cent)	November 7—10 ... (November 21—24)	November 2—17 ...	41	0	6	0	0	0+1?	Nilgiris	0
1937-38	No information ... (December 2; 1 per cent)	November 13—16 ...	October 27 to November 17	60	0	0	0	0	...	...	0
			TOTAL ...	4,9 66	51	146	38	138	181+41?	...	651 (190+113?)

:uate foot-

TABLE VII

Relevant and Possibly Relevant winds at different heights in relation to the dissemination of **Black Rust** *during 1932 to 1938*

Serial number	Province and Station. Altitude in feet above sea level within brackets. Period of study	Height of winds in feet above sea level	Total number of winds studied	Relevant winds: (a) Total number, (b) Number for specified height only followed by spore showers, (c) Number along with winds at other heights followed by spore showers			Possibly† Relevant winds: (i-iv) From different hills, (v) Number for specified height only followed by spore showers, (vi) Number along with winds at other heights followed by spore showers					
				(a)	(b)	(c)	(i)	(ii)	(iii)	(iv)	(v)	(vi)
	PUNJAB											
1	Lyallpur (605) ...	1,640	82	2	0	0	0	15	9	0	1	7
	6 years	3,280	83	3	0	0	0	14	5	0	0	5
		4,920	81	1	0	0	0	7	3	0	0	2
		6,560	85	0	0	0	0	9	2	0	0	3
2	Hoshiarpur* (702)	1,640	58	0	0	0	0	22	11	0	1	12
	3 years	3,280	57	0	0	0	0	22	5	0	0	12
		4,920	58	1	1	0	0	16	5	0	0	11
		6,560	59	0	0	0	0	15	2	0	0	7

† Such winds as originated from or passed over hill stations where this rust had been found to oversummer or observed in an advanced stage from year to year, due to early sowings, long before the period of winds, were taken as 'possibly relevant,' as explained under Methods of Study

(*i*) Number of winds coming from central Nepal

(*ii*) Number of winds coming from Kashmir and Murree hills

(*iii*) Number of winds coming from Siwalik and Kumaon hills

(*iv*) Number of winds coming from Nilgiris

* Situated at foot-hills

Note.—In addition to the number of 'relevant winds' followed by spore showers, as shown in columns (*b*) and (c) above, there were 41 such winds at different heights, in relation to which spore showers also occurred but they are not included in those columns because the periods of spore showers were not strictly in accordance with the heights of the winds concerned, as explained under sub-head 10 (*ii*). Similarly, 113 'possibly relevant' winds have not been shown in columns (*v*) and (*vi*). These numbers are, however, included in columns (*a*) and (*i*)—(*iv*). In most of these cases, spore showers took place a day or two earlier than the maximum period reckoned for each height (1,640 to 6,560 ft. above sea level), possibly because of the absence of great disturbance in the air below those winds. It is equally likely that some of those spore showers were caused by winds, from other and unknown sources, which blew during the intervals between daily meteorological observations.

TABLE VII—*contd.*

Serial number	Province and Station. Altitude in feet above sea level within brackets. Period of study	Height of winds in feet above sea level	Total number of winds studied	Relevant winds: (*a*) Total number, (*b*) Number for specified height only followed by spore showers, (*c*) Number along with winds at other heights followed by spore showers			Possibly Relevant winds: (*i-iv*) From different hills, (*v*) Number for specified height only followed by spore showers, (*vi*) Number along with winds at other heights followed by spore showers					
				(*a*)	(*b*)	(*c*)	(*i*)	(*ii*)	(*iii*)	(*iv*)	(*v*)	(*vi*)
3	Rawalpindi* (1,674)	3,280	34	0	0	0	0	2	0	0	0	1
	2 years	4,920	34	0	0	0	0	2	0	0	0	2
		6,560	34	0	0	0	0	7	1	0	3	3
4	Karnal (900) ...	1,640	69	4	1	1	0	16	18	0	1	14
	5 years	3,280	69	4	0	1	0	12	11	0	1	8
		4,920	67	3	1	1	0	10	7	0	0	5
		6,560	65	0	0	0	0	10	4	0	0	4
	SIND											
5	Sakrand (120) ...	1,640	59	1	1	0	0	0	3	0	0	0
	5 years	3,280	65	1	0	0	0	0	0	0	0	0
		4,920	65	1	0	0	0	0	0	0	0	0
		6,560	66	0	0	0	0	0	0	0	0	0
	DELHI											
6	Delhi (714) ...	1,640	16	0	0	0	0	7	3	0	2	4
	1 year	3,280	16	0	0	0	0	3	1	0	0	1
		4,920	16	0	0	0	0	1	0	0	0	0
		6,560	16	0	0	0	0	1	0	0	0	0
	UNITED PROVINCES											
7	Agra (554) ...	1,640	93	5	1	3	1	9	28	0	7	5
	6 years	3,280	91	2	0	2	0	3	18	0	0	3
		4,920	91	5	3	1	0	1	6	0	0	0
		6,560	92	1	0	0	0	1	1	0	0	1

* Situated at foot-hills

TABLE VII—*contd.*

Serial number	Province and Station. Altitude in feet above sea level within brackets. Period of study	Height of winds in feet above sea level	Total number of winds studied	Relevant winds: (a) Total number, (b) Number for specified height only followed by spore showers, (c) Number along with winds at other heights followed by spore showers			Possibly Relevant winds: (i-iv) From different hills, (v) Number for specified height only followed by spore showers, (vi) Number along with winds at other heights followed by spore showers					
				(a)	(b)	(c)	(i)	(ii)	(iii)	(iv)	(v)	(vi)
8	Gorakhpur* (257) ...	1,640	73	9	0	0	14	1	23	0	3	4
	5 years	3,280	70	8	0	0	11	1	20	0	1	4
		4,920	72	3	0	0	3	3	17	0	0	3
		6,560	74	4	1	0	1	2	24	0	1	3
	BIHAR											
9	Pusa (188) ...	1,640	87	20	1	8	18	0	5	0	1	7
	6 years	3,280	86	21	0	12	16	1	5	0	0	6
		4,920	86	15	1	9	9	4	5	0	0	3
		6,560	86	14	0	7	8	1	3	0	0	3
10	Sabour (122) ...	1,640	49	11	3	2	6	0	4	0	0	1
	4 years	3,280	56	12	0	5	14	0	3	0	0	3
		4,920	59	14	2	7	12	2	2	0	0	4
		6,560	54	20	1	7	9	1	1	0	0	2
	BENGAL											
11	Mymensingh (62)	1,640	27	1	‡	‡	0	0	0	0	‡	‡
	2 years	3,280	28	2	‡	‡	0	0	0	0	‡	‡
		4,920	29	6	‡	‡	0	0	1	0	‡	‡
		6,560	31	7	‡	‡	4	0	0	0	‡	‡

* Situated at foot-hills
‡ No slides were exposed at this station

TABLE VII—*contd.*

Serial number	Province and Station. Altitude in feet above sea level. Number within brackets. Period of study	Height of winds in feet above sea level	Total number of winds studied	Relevant winds : (*a*) Total number, (*b*) Number for specified height only followed by spore showers, (c) Number along with winds at other heights followed by spore showers			Possibly† Relevant winds : (*i-iv*) From different hills, (*v*) Number for specified height only followed by spore showers, (*vi*) Number along with winds at other heights followed by spore showers					
				(*a*)	(*b*)	(*c*)	(*i*)	(*ii*)	(*iii*)	(*iv*)	(*v*)	(*vi*)
	ASSAM											
12	Dhubri* (115) ...	1,640	34	0	‡	‡	0	0	1	0	‡	‡
	2 years	3,280	37	0	‡	‡	0	0	2	0	‡	‡
		4,920	35	4	‡	‡	1	0	0	0	‡	‡
		6,560	26	2	‡	‡	0	1	2	0	‡	‡
	CENTRAL PROVINCES											
13	Jubbulpore (1,289)	1,640	109	14	3	6	2	2	14	0	7	1
	6 years ...	3,280	101	8	2	4	3	4	8	0	5	1
		4,920	102	8	0	4	0	1	2	0	0	0
		6,560	104	13	1	5	0	1	2	0	1	0
14	Khandwa (1,044) ...	1,640	14	3	3	0	0	0	0	0	0	0
	1 year ...	3,280	12	1	0	0	0	0	0	0	0	0
		4,920	10	2	0	1	0	0	0	0	0	0
		6,560	11	3	0	2	0	0	0	0	0	0
	ORRISSA											
15	Pottangi ... (3,000—3,500)	3,280	34	0	‡	‡	0	0	0	0	‡	‡
	(Jeypore Agency) area.	4,920	35	0	‡	‡	0	0	0	0	‡	‡
	2 years ...	6,560	33	0	‡	‡	0	0	0	0	‡	‡
		9,840	13	0	‡	‡	0	0	0	0	‡	‡

‡ No slides were exposed at this station
* Situated at foot-hills

TABLE VII—*contd.*

Serial number	Province and Station. Altitude in feet above sea level. Number within brackets. Period of study	Height of winds in feet above sea level	Total number of winds studied	Relevant winds: (*a*) Total number, (*b*) Number for specified height only followed by spore showers, (*c*) Number along with winds at other heights followed by spore showers			Possibly† Relevant winds: (*i-iv*) From different hills, (*v*) Number for specified height only followed by spore showers, (*vi*) Number along with winds at other heights followed by spore showers					
				(*a*)	(*b*)	(*c*)	(*i*)	(*ii*)	(*iii*)	(*iv*)	(*v*)	(*vi*)
	BOMBAY-DECCAN											
16	Poona* (1,834) ...	3,280	78	1	1	0	0	0	0	0	0	0
	5 years ...	4,920	75	0	0	0	0	0	0	0	0	0
		6,560	74	0	0	0	0	0	0	0	0	0
17	Dharwar (2,340) ...	3,280	89	15	0	13	0	0	0	0	0	0
	6 years ...	4,920	87	17	0	14	0	0	0	0	0	0
		6,560	79	16	2	11	0	0	0	0	0	0
		9,840	9	5	0	5	0	0	0	0	0	0
	HYDERABAD-DECCAN											
18	Parbhani (1,350) ...	1,640	17	0	0	0	0	0	0	0	0	0
	3 years ...	3,280	38	9	0	0	0	0	0	0	0	0
		4,920	34	1	0	0	0	0	0	0	0	0
		6,560	24	1	0	0	0	0	0	0	0	0
		9,840	11	0	0	0	0	0	0	0	0	0
19	Himayatsagar (1,776)	3,280	69	0	0	0	0	0	0	0	0	0
	4 years ...	4,920	69	2	2	0	0	0	0	0	0	0
		6,560	67	1	1	0	0	0	0	0	0	0
		9,840	11	0	0	0	0	0	0	0	0	0

Situated at foot-hills

TABLE VII—*contd.*

Serial number	Province and Station. Altitude in feet above sea level. Number within brackets. Period of study	Height of winds in feet above sea level	Total number of winds studied	Relevant winds. (*a*) Total number, (*b*) Number for specified height only followed by spore showers, (*c*) Number along with winds at other heights followed by spore showers			Possibly† Relevant winds : (*i-iv*) From different hills, (*v*) Number for specified height only followed by spore showers, (*vi*) Number along with winds at other heights followed by spore showers					
				(*a*)	(*b*)	(*c*)	(*i*)	(*ii*)	(*iii*)	(*iv*)	(*v*)	(*vi*)
	MADRAS											
20	Coimbatore* (1,341) 3 years ...	1,640	53	7	3	0	0	0	0	0	0	0
		3,280	53	2	0	1	0	0	0	0	0	0
		4,920	52	8	2	1	0	0	0	0	0	0
		6,560	50	7	1	2	0	0	0	0	0	0
	MYSORE											
21	Bangalore (3,021) ... 1 year ...	3,280	16	0	0	0	0	0	0	0	0	0
		4,920	15	0	0	0	0	0	0	0	0	0
		6,560	16	1	0	0	0	0	0	0	0	0
		8,200	16	0	0	0	0	0	0	0	0	0
22	Mandya* (2,580) ... 4 years ...	3,280	67	1	0	0	0	0	0	2	0	0
		4,920	67	1	0	1	0	0	0	0	0	0
		6,560	66	1	0	0	0	0	0	0	0	0
		8,200	16	0	0	0	0	0	0	0	0	0
		9,840	22	1	0	0	0	0	0	0	0	0
		13,120	1	1	0	0	0	0	0	0	0	0
	(Trajectories based on cloud observations)	9,840	8	8	3	3	0	0	0	0	0	0
		13,120	1	1	0	1	0	0	0	0	0	0
23	Chitaldroog* (2,405) 6 years ...	3,280	100	2	0	0	0	0	0	0	0	0
		4,920	102	3	0	0	0	0	0	0	0	0
		6,560	95	2	0	0	0	0	0	0	0	0
		9,840	21	0	0	0	0	0	0	0	0	0
	TOTAL ...	...	4,966	373	41	140	132	230	287	2	35	155

* Situated at foot-hills

Table VIII

Sum of data given in 'ap No as 'rel nt' for elatio ation some of tl nd be led
Black Ru

Map Number	Year	Height of the wind in feet above sea level	Date of wind trajectory	Dates of spore shower soon after the wind. Dates of subsequent showers, if any, 14 to 10 days or so before rust appearance within brackets	Date of rust appearance, as reported from the station. Incidence* within brackets	Area or stations passed over. Dates of rust appearance or incidence* where known wthin braickets
				PUNJAB		
				Lyallpur (605 feet above sea level		
47	1936-37	1,640	February 28 ...	March 1—4 ... (March 8—11) ...	March 20 ...	Peshawar (February 27) Rawalpindi
	1936-37	3,280	February 28	March 1—4 ... (March 8—11) ...	March 20 ...	Peshawar (February 27)
	1936-37	4,920	February 28 ...	March 1—4 ... (March 8—11) ...	March 20 ...	Kashmir, Murree, Rawalpindi
	1936-37	6,560	February 28 ...	March 1—4 ... (March 8—11) ...	March 20 ...	Peshawar (February 27)
48	1937-38 ...	1,640	March 13 ...	March 14—17 ... (March 21—24) ...	April 1 ...	Peshawar (March 3)
	1937-38 ...	3,280	March 13 ...	March 14—17 ... (March 21—24) ...	April 1 ...	Peshawar (March 3)
	1937-38 ...	4,920	March 13 ...	March 14—17 ... (March 21—24) ...	April 1 ...	Peshawar (March 3)
	1937-38 ...	6,560	March 13 ...	March 14—17 ... (March 21—24) ...	April 1 ...	Peshawar (March 3)

* Observations made by members of the rust research staff or occasionally by the writer. Range of crop infection relates to different fields and on different varieties at that locality

Note.—As stated under *Methods of Study,* the date of rust appearance was put by back by 3—4 weeks in cases where a meml er of the rust research staff found heavy infection (70 per cent or above) within a week or so of the reported date of first appearance of rust at the station concerned.

TABLE V ontd

Map Number	Year	Height of the wind in feet above sea level	Date of wind trajectory	Dates of spore shower soon after the wind. Dates of subsequent showers, if any, 14 to 10 days or so before rust appearance within brackets	Date of rust appearance, as reported from the station. Incidence within brackets	Area or stations passed over. Dates of rust appearance or incidence where known within brackets
				Lyallpur (605 feet above sea level)—*Contd.*		
49	1937-38 ...	1,640	March 15 ...	March 14—17** (March 21—24) ...	April 1 ...	Siwalik range, Hoshiarpur, Gurdaspur (March 17), Lahore
	1937-38	3,280	March 15 ...	March 14—17** ... (March 21—24) ...	April 1 ...	Kashmir
	1937-38 ...	6,560	March 15 ...	March 14—17** ... (March 21—24) ...	April 1 ...	N.-W. F. Province
				BOMBAY-DECCAN		
				Poona (1,834 feet above sea level)		
50	1933-34 ...	3,280	December 3 ...	December 4—7 (. — .) ...	January 1st week ...	Lyallpur (March 1st week), Agra February (6), Parbhani (January 13)
	1933-34 ...	4,920	December 3 ...	December 4—7 (. — .) ...	January 1st week ...	Jubbulpore (January 28); Nagpur, Parbhani (January 13)
	1933-34 ...	6,560	December 3 ...	December 4—7 (. — .) ...	January 1st week ...	Ajmer (March 9), Jubbulpore (January 28) Nagpur, Parbani (January 13)

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TABLE V—*Contd.*

Map Number.	Year	Height of the wind in feet above sea level	Date of wind trajectory	Dates of spore shower soon after the wind. Dates of subsequent showers, if any, 14 to 10 days or so before rust appearance within brackets	Date of rust appearance, as reported from the station. Incidence within brackets	Area or stations passed over. Dates of rust appearance or incidence where known within brackets
			Poona (1,834 feet above sea level)—*Contd.*			
51	1934-35 ...	3,280	December 16	December 17—20 ... (December 27—31 and December 31—January 3)	January 2nd week	Kurnool
	1934-35 ...	4,920	December 16	December 17—20 ... (December 27—31 and December 31—January 3)	January 2nd week	Pottangi (January 18; 1 per cent) Himayatsagar (January 19, 1-100 per cent)
	1934-35 ...	6,560	December 16 ...	December 17—20 ... (December 27—31 and December 31—January 3)	January 2nd week	Mahableshwar
52	1936-37 ...	3,280	November 25 ...	November 26—30 ... (November 30—December 3)	December 14 ...	Guntur (January 2nd week) Himayatsagar (February 8)
	1936-37 ...	4,920	November 25 ...	November 26—30 ... (November 30—December 3)	December 14 ...	Hyderabad State
	1936-37 ...	6,560	November 25 ...	November 26—30 ... (November 30—December 3)	December 14 ...	Ajmer, Khandwa.

VIII—*contd*

Map Number.	Year	Height of the wind in feet above sea level	Date of wind trajectory	Dates of spore shower soon after the wind. Dates of subsequent showers, if any, 14 to 10 days or so before rust appearance within brackets	Date of rust appearance, as reported from the station. Incidence within brackets	Area or stations passed over. Dates of rust appearance or incidence where known within brackets
				HYDERABAD-DECCAN		
				Himayatsagar near Hyderabad (1,776 feet above sea level)		
53	1933-34 ...	3,280	November 29 ...	November 30—December 7 ... (November 30—December 7)	January Middle ... (January 20—21; 5-100 per cent)	Sabour (March 8); Pottangi (January 13-14; 100 per cent)
	1933-34 ...	4,920	November 29 ...	November 30—December 7 ... (November 30—December 7)	January Middle ... (January 20—21; 5-100 per cent)	East Coast
	1933-34 ...	6,560	November 29 ...	November 30—December 7 ... (November 30—December 7)	January Middle ... (January 20—21; 5-100 per cent)	Mymensingh, Pottangi (January 13—14; 100 per cent)
				MYSORE STATE		
				Chitaldroog (2,405 feet above sea level)		
54	1933-34 ...	3,280	November 2 ...	October 31—November 3** ... (. — .)	January 12 ... (December 15; over 60 per cent)	East Coast
	1933-34 ...	4,920	November 2 ...	October 31—November 3** ... (. — .)	January 12 ... (December 15; over 60 per cent)	Simla (March 15); Bareilly (February 27); Jubbulpore (January 28)
	1933-34 ...	6,560	November 2 ...	October 31—November 3** ... (. — .)	January 12 ... (December 15; over 60 per cent)	Simla, Jubbulpore, Nagpur, Himayatsagar (January 20—21, 5-100 per cent)

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TABLE IX

Earliest date and the usual period of the appearance of **Black Rust** *in the foot-hills and plains*

Serial number	Province	Name of Station	Earliest date of rust appearance, as reported from the station. Incidence+ within brackets	Usual period of rust appearance
1	PUNJAB ...	Gurdaspur* ...	March 17 ...	March 4th week
2		Hoshiarpur* ...	February 1st week ...	February 2nd week
3		Rawalpindi* ...	March 3rd week ...	April 3rd week
4		Rupar †	March 1st week ...	...
5		Lyallpur	March 1st week ...	March 3rd week
6		Khanewal † ...	March 23 ...	...
7		Karnal	February 27 ...	March 1st—2nd week
8		Ambala ...	(March 17; 10-20 per cent)	March—April
9		Jullundar	(March 12; traces) ...	March—April
10	N.-W. F. PROVINCE	Peshawar	February 27 ...	March 1st week
11	SIND ...	Sakrand	February 28 ...	March 2nd—3rd week
12	DELHI	Delhi	(February 22; one plant)	March 3rd week
13	UNITED PROVINCES	Dehradun* ...	(March 18; traces) ...	March 3rd week
14		Gorakhpur * ...	December 30 ...	January 2nd week
15		Gainsari *	(February 15; traces)	February 2nd—3rd week
16		Nautanwa* ...	(January 14; 20 per cent)	January 1st—3rd week
17		Haldwani* ...	(February 4th week) ... (March 21; 80 per cent)	March 1st week
18		Naipalganj Road*‡ ...	(January 10; traces) ...	...
19		Shahjahanpur ...	(February 1—2; traces)	February 1st—3rd week
20		Bareilly	February 8 ...	February 4th week—March 1st week
21		Chandausi ‡ ...	(January 30; common)	...
22		Barabanki ...	(December 29; traces)	January 3rd—4th week

+ Observations made by members of the rust research staff or occasionally by the writer. Range of crop infection relates to different fields and on different varieties at that locality.

* Situated at foot-hills

† From this station rust was reported only once.

‡ At this station rust was observed only once.

TABLE IX—*contd.*

Serial number	Province	Name of Station	Earliest date of rust appearance, as reported from the station. Incidence within brackets	Usual period of rust appearance
23		Gonda	(January 3 ; traces) ...	January—February
24		Fyzabad	December 4th week ...	January Middle—February 3rd week
25		Agra	(February 6 ; traces) ...	February 3rd week
26		Cawnpore	December 4th week ...	February 1st—2nd week
27		Lucknow	(January 31 ; 20 per cent)	January 3rd week—February 3rd week
28		Allahabad	February 2 ...	February 1st—2nd week
29		Benares	January 27 ...	End of January—February
30		Jhansi ...	(February 21 ; traces—40 per cent)	February 1st—4th week
31	BIHAR ...	Pusa	January 31 ...	February 2nd week
32		Patna	January 4th week ...	January End—Early March
33		Sabour	February 2nd week ...	March 1st week
34	BENGAL ...	Mymensingh ...	(February 15 ; traces—3 per cent)	February 1st—4th week
35	ASSAM ...	Dhubri*	(January 23 ; 1-25 per cent)	January End to February End
36	RAJPUTANA ...	Ajmer	February 26 ...	March 1st—2nd week
37		Sri Ganganagar † ...	March 1st week ...	...
38	CENTRAL INDIA	Indore	February 3rd week ... (February 27 ; 100 per cent)	February 3rd week
39	CENTRAL PROVINCES ...	Jubbulpore ...	January 28 ...	February 3rd week
40		Nagpur	February 2 ...	February 3rd—4th week
41		Khandwa	January 30 ...	February—March
42		Powarkhera... ...	January 19 ...	February 1st—2nd week
43		Saugor ‡	(February 26 ; traces—60 per cent)	...

* Situated at foot-hills
† From this station rust was reported only once
‡ At this station rust was observed only once

TABLE IX—*contd.*

Serial number	Province	Name of Station	Earliest date of rust appearance, as reported from the station. Incidence within brackets	Usual period of rust appearance
44		Raipur	February 22 ...	February End—Early March
45	BOMBAY-DECCAN	Poona*	November 2nd week ...	December—January
46		Niphad * ...	December 3 ...	January 1st week
47		Dharwar	November 21 ...	December—January
48		Arbhavi	November 25 ...	December End—Early January
49		Dohad	January 31 ...	February 2nd—4th week
50		Baroda	January 28 ...	February 1st—3rd week
51		Broach	January 3 ...	January—February Middle
52		Jagudan	January 29 ... (February 6; 0-100 per cent)	February 1st—2nd week
53		Amreli	December 20 ...	December End—Early February
54	HYDERABAD-DECCAN ...	Parbhani	December 15 ...	January 2nd—3rd week
55		Himayatsagar (near Hyderabad) ...	December 9 ...	January—February
56	MADRAS ...	Bellary	(November 14; 1-2 per cent)	January 1st week
57		Coimbatore * ...	September 10† ...	February 1st—3rd week
58		Guntur	December End ...	January 1st—2nd week
59		Udumalpet ‡ ...	(March 9; 0-80 per cent)	...
60	MYSORE STATE ...	Mandya*	October 16§ ...	December—January
61		Hiriyur (Chitaldroog)*	(October 22; 5 per cent)‖	December—January

* Situated at foot-hills
† In miniature plots sown, at the request of the writer, during June-July, 1937
‡ At this station rust was observed only once
§ On wheat sown in a miniature plot in August, 1935, at the request of the writer
‖ On early wheat crop sown in August, 1935

Explanatory notes on Map Nos. 2 to 54. Ref. Tables V and VIII.

(*i*) In order to economise space only portions of maps showing the wind-trajectories have been included.
(*ii*) The scale of each map is 1 in.—341.3 miles.
(*iii*) Shaded portions represent hills and hilly tracts.
(*iv*) Each wind-trajectory bears the label A, B or C etc., representing heights of 1640, 3280, 4920 feet above sea level. respectively. These heights have been mentioned in the foot-notes to each map.
(*v*) Wherever no date of rust appearance was reported from the station concerned information, if available, regarding the incidence of rust on the date of observation by the writer or a member of the rust research staff is given within brackets.

PART THREE

Dissemination of *Puccinia triticina* Erikss.

12. Review of literature

With regard to the dissemination of *P. triticina*, the brown or leaf rust of wheat, there is very little information in the literature. The writer [Mehta, 1925] observed that in India outbreaks of brown rust in the plains are probably caused by uredospores blown down from the hills where it is able to oversummer.

Shitikova-Roussakova [1927] stated that direction and strength of the wind play a dominant part in the introduction of rust infection from those regions where owing to prevailing natural conditions the rust appears first. According to her, brown rust of wheat is disseminated to the Amur region from North Manchuria where, like the black stem-rust, it is able to overwinter in the uredostage.

Roussakoff [1929] made a similar observation regarding the dissemination of inoculum causing simultaneous infection of winter and spring wheats at Eysk, the U. S. S. R. from outside areas where this rust had successsfully over-wintered. This author also states that spores of *P. triticina* are carried 50 to 250 kilo-meters over the sea without losing their infectivity.

The writer [Mehta, 1931] has already published observations on the dissemination of wheat rusts from the hills of India to the plains.

Shitikova-Roussakova [1931] again observed that the appearance of *P. triticina* on spring wheats in the Amur region in 1926 was exclusively caused by the introduction of spores from North Manchuria by southerly winds. In the following year, according to this author, rust was introduced into the Yeisk (North Caucasus) region from the Rostoff district where its spores had over-wintered owing to mild weather.

The writer [Mehta, 1933] again observed that uredospores of this rust had been caught at several stations in the plains of India, well before its appearance on the local wheat crop.

According to Ukkelberg [1933] the average rate of fall of uredospores of *P. triticina* in still air is 12.62 ± 0.07 mm. per second. The average theoretical dispersal distance of uredospores of this rust from an altitude of 5,000 ft. by a 30-mile wind was found to be 1,000 miles.

Săvulescu [1938] stated that in Rumania the principal sources of infection by all the three rusts of wheat are the air-borne uredospores from the surrounding wheat-growing countries.

According to Craigie [1939], leaf rust of wheat is regularly introduced into Manitoba by wind-borne spores as there is little possibility of its survival locally from year to year and spores are always present in the air in advance of infection of the wheat crop.

The writer [Mehta, 1939, 1940] referred to two important foci in the hills wherefrom this rust is disseminated rather early in the season.

13. Study of dissemination with the help of aeroscope-slides

Full information regarding this study is given in Tables X and XI.

14. Study of balloon and kite-slides

As stated in Part Two, spore catching experiments with the help of balloons and kites were carried out only at the Agra Observatory and the data obtained from this study are given in Table XII.

15. Study of dissemination with the help of wind-trajectories

During 1932 to 1938, 3,412 wind-trajectories were studied in connection with the dissemination of brown rust to representative stations.

As with black rust, the relevancy of winds was carefully scrutinized in relation to the dates of spore showers and of rust appearance at those stations. Representative trajectories are reproduced in Map, Nos. 55 to 89. Full information regarding these winds is supplied as foot-notes to the maps.

The general observations made in Part Two concerning 'relevant' winds apply here also. The details given in Maps 55 to 89 are summarized in Table XIII. In Table XIV detailed information regarding the total number of wind-trajectories studied, the number of winds found 'relevant' as well as those 'possibly relevant', for all the four heights taken together, is supplied. Information about the relevancy of winds of different heights is summarized in Table XV.

16. Discussion

Much of what has been stated in Part Two applies to brown rust as well. The various aspects of the dissemination of this rust are briefly discussed below :

(i) Dates of rust appearance in relation to spore showers

It is clear from Tables X and XI that at a large number of stations uredospores of brown rust were caught 4 to 2 weeks before its outbreak on the local wheat crop.

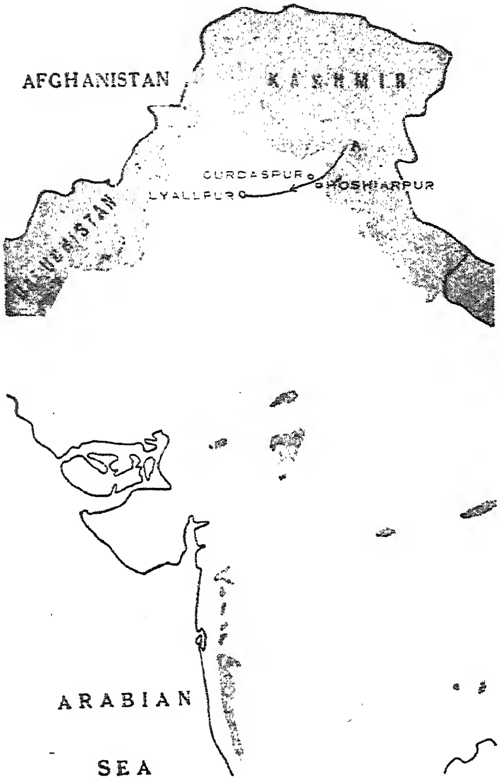
On the other hand, from the study of aeroscope-slides no spore showers could be detected just before the commencement of the incubation period at several stations during certain years. Although spores were caught at most of the stations in Peninsular India, this rust appeared only occasionally and in some years it was reported to be altogether absent. This is probably due to the fact that brown rust thrives under a range of temperature slightly lower than the black, as previously recorded by the writer. The difficulties in the way of an adequate explanation of the absence of spore showers in all cases where rust appeared have already been discussed in Part Two. This matter is further dealt with under General Discussion and Conclusions in Part Five.

(ii) Spore showers in relation to winds

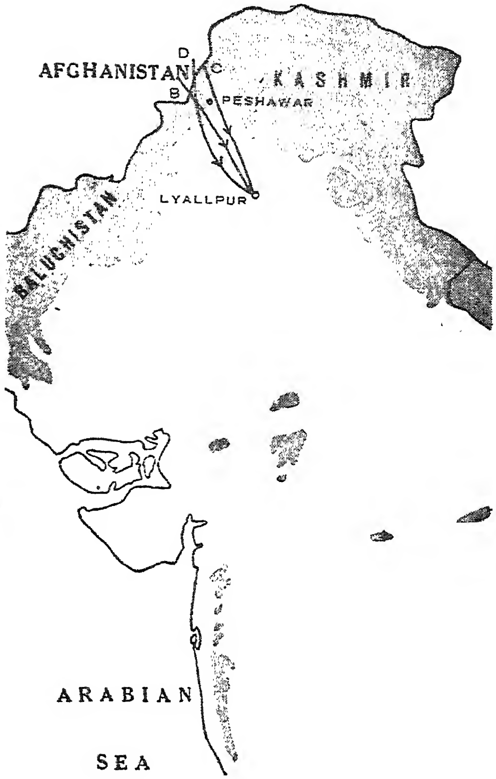
Scrutiny of data regarding the relevancy of winds of different heights in relation to spore showers and dates of rust appearance was done on the lines described under sub-head 10 (ii) dealing with black rust.

The maps, referred to above, show a distinct correlation between the wind-curves that have been reproduced and subsequent spore showers which in all probability led to rust outbreaks. As with black rust, such winds as started from or passed over stations where the outbreak occurred 1-2 months earlier

MAP NO. 55



MAP NO. 56



55. LYALLPUR (605 ft. above sea level). BROWN RUST. ORIGINAL MAP No 1,504.

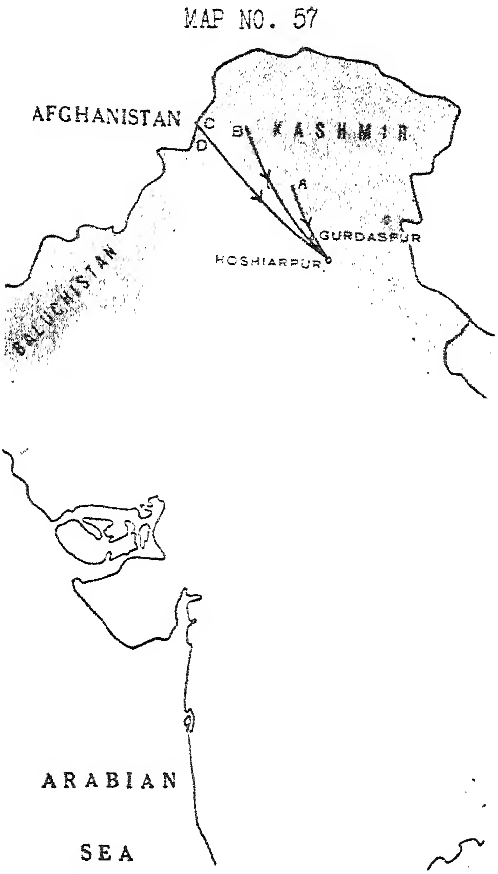
Date and height of trajectory in feet ...	February 25, 1937 : A—1640.
Dates of spore showers soon after the wind ...	February 25—March 1 & March 1—4.
Dates of spore shower 14—10 days before rust appearance	March 8—11.
Date of rust appearance	March 20.

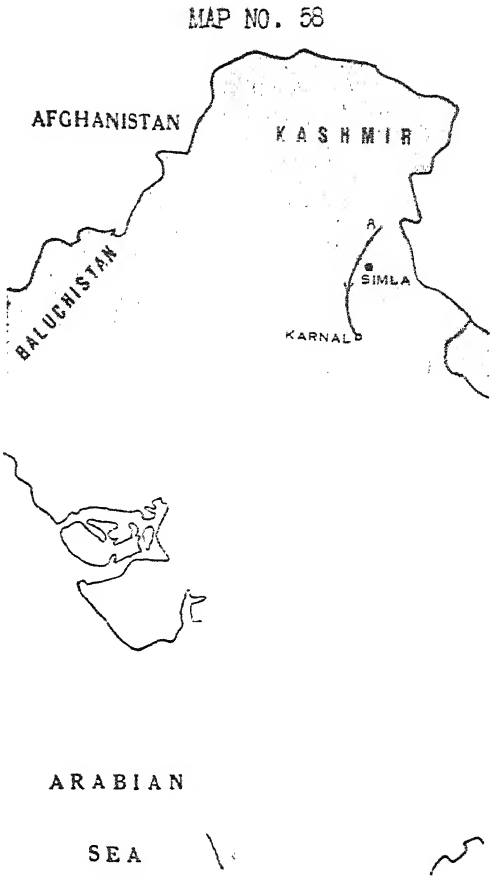
A—The wind was traceable from Siwalik hills and passed near Gurudaspur and Hoshiarpur where this rust had appeared on December 4, 1936 and January 15, 1937 respectively.

56. LYALLPUR (605 ft. above sea level). BROWN RUST. ORIGINAL MAP. No. 1,164.

Date and heights of trajectories in feet ...	March 3, 1936 : B—3280, C—4920, D—6560.
Dates of spore showers soon after the winds ...	March 3—6 & 6—10.
Dates of spore shower 14—10 days before rust appearance	March 10—14.
Date of rust appearance	March 27, 1936.

B, C & D—The winds were traceable from N.-W. F. Province and passed near Peshawar where brown rust had appeared in the second week of January, 1936.





57. HOSHIARPUR (702 ft. above sea level). BROWN RUST. ORIGINAL MAP No. 1,532.

Date and heights of trajectories in feet ...	December 22, 1936 : A—1640, B—3280, C—4920, D—6560.
Dates of spore shower soon after the winds ...	No spores were caught.
Dates of spore shower 14—10 days before rust appearance	January 5—8.
Date of rust appearance	January 15, 1937.

A—The wind was traceable from Kashmir and passed over Gurudaspur where brown rust had appeared on December 4.

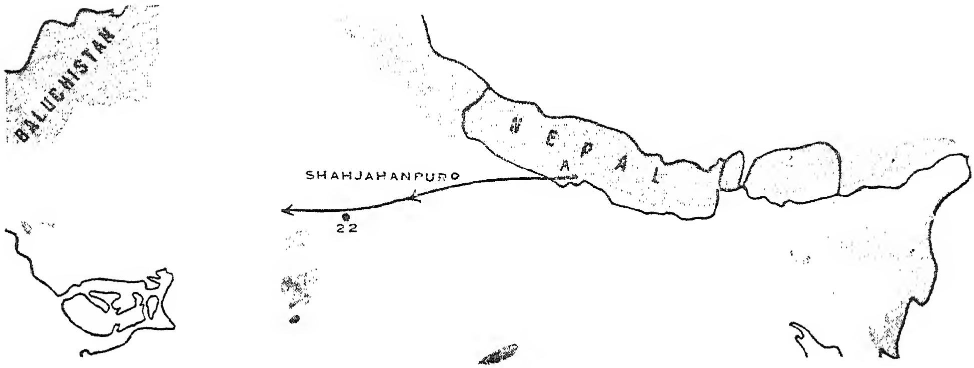
B, C & D—The winds were traceable from N.-W. F. Province and passed near Gurudaspur where brown rust had appeared on December 4.

58. KARNAL (900 ft. above sea level). BROWN RUST. ORIGINAL MAP No. 772.

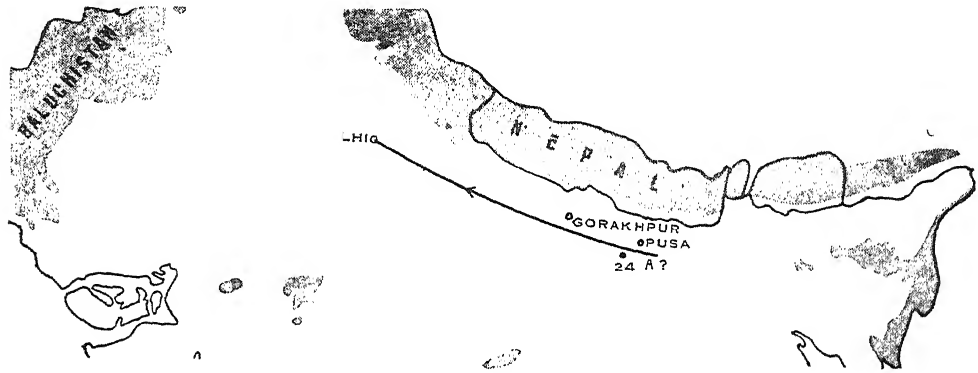
Date and height of trajectory in feet ...	February 4, 1935 : A—1640.
Dates of spore shower soon after the wind ...	No spores were caught.
Dates of spore shower 14—10 days before rust appearance	No spores were caught.
Date of rust appearance	February 26, 1935.

A—The wind was traceable from Siwalik range and passed near Simla where brown rust had appeared on January 18, 1935.

MAP NO. 59



MAP NO. 60



59. SAKRAND (120 ft. above sea level). BROWN RUST. ORIGINAL MAP No. 1,601.

Date and height of trajectory in feet ... February 23, 1937 : A—1640.

Dates of spore shower ... ... No spores were caught.

Dates of spore shower 14—10 days before rust appearance ... ... No spores were caught.

Date of rust appearance ... ... March 20, 1937.

A—The wind was traceable from central Nepal, where 10 per cent crop infection was observed on December 6, 1936 and passed near Shahjahanpur where this rust had appeared in the fourth week of January 1937.

60. DELHI (714 ft. above sea level). BROWN RUST. ORIGINAL MAP No. 2,124.

Date and height of trajectory in feet ... January 25, 1938 : A—1640.

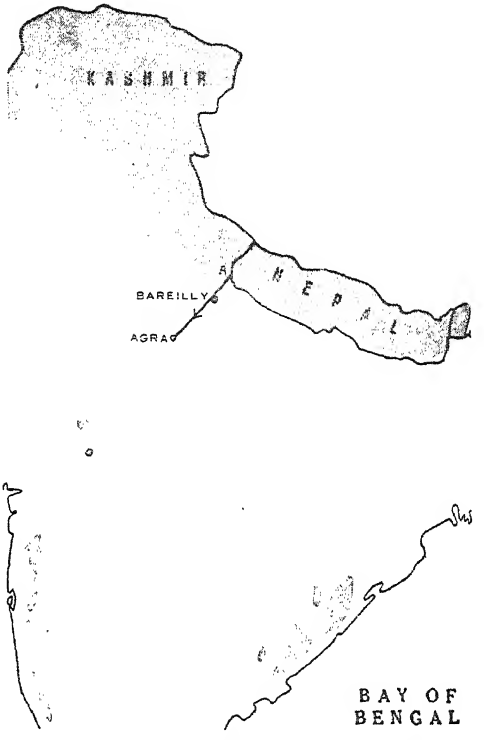
Dates of spore shower ... ... No spores were caught before rust appearance.

Date of rust appearance ... ... February 15, 1938.

A—The wind was traceable from Bihar on January 24, passed near Pusa, where brown rust had appeared on January 9 and near Gorakhpur where up to 3 per cent crop infection with this rust was observed on January 7, 1938.

MAP NO. 61

MAP NO. 62



61. AGRA (554 ft. above sea level). BROWN RUST. ORIGINAL MAP No. 344.

Date and height of trajectory in feet ... January 10, 1934: A—1640.

Dates of spore shower soon after the wind ... January 10—14.

Dates of spore shower 14—10 days before rust appearance ... ... January 21—24.

Date of rust appearance ... ... February 1, 1934.

A—The wind was traceable from central Nepal and passed over Gorakhpur where brown rust was found in traces on December 14, 1933.

62. AGRA (554 ft. above sea level). BROWN RUST. ORIGINAL MAP No. 1,624.

Date and height of trajectory in feet ... January 25, 1937: A—1640.

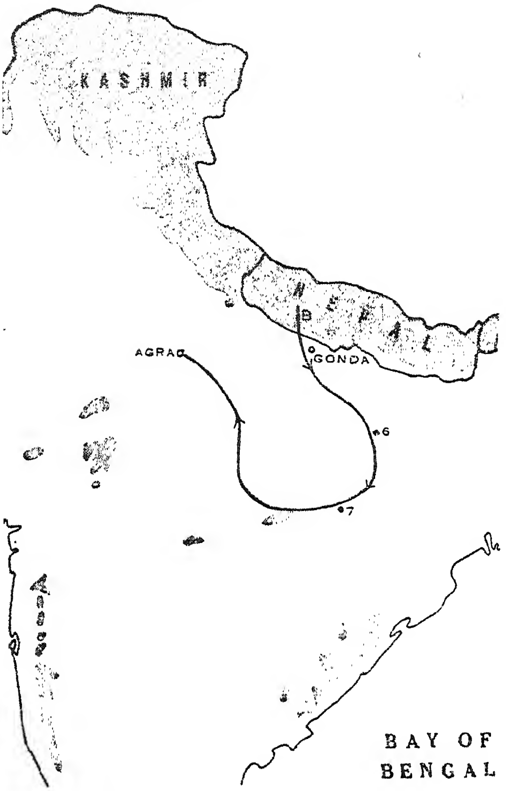
Dates of spore shower soon after the wind ... No spores were caught.

Dates of spore shower 14—10 days before rust appearance ... ... February 3—6.

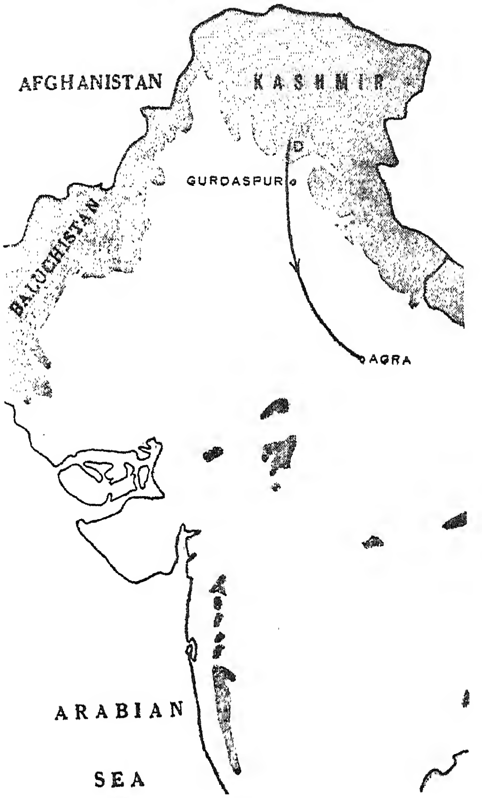
Date of rust appearance ... ... February 15, 1937.

A—The wind was traceable from Kumaon hills and passed over Bareilly where up to 20 per cent crop infection with brown rust was observed on December 23, 1936.

MAP NO. 63



MAP NO. 64



63. AGRA (554 ft. above sea level). BROWN RUST. ORIGINAL MAP No. 358.

Date and height of trajectory in feet ... January 8, 1934 : B—3280.

Dates of spore showers soon after the wind ... January 10—14.

Dates of spore shower 14—10 days before rust appearance ... ... January 21—24.

Date of rust appearance ... ... February 1, 1934.

B—The wind was traceable from western Nepal and passed near Gonda where brown rust was observed in traces on December 10, 1933.

64. AGRA (554 ft. above sea level). BROWN RUST. ORIGINAL MAP No. 1,626.

Date and height of trajectory in feet ... January 27, 1937 : D—6560.

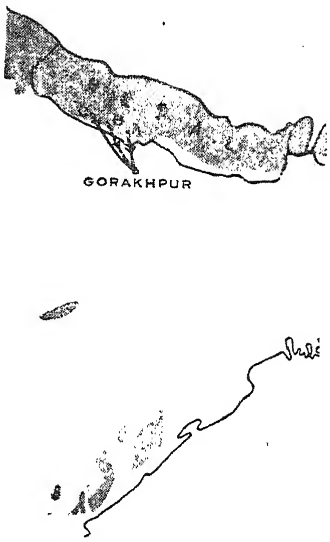
Dates of spore shower soon after the wind ... No spores were caught.

Dates of spore shower 14—10 days before rust appearance ... ... February 3—6.

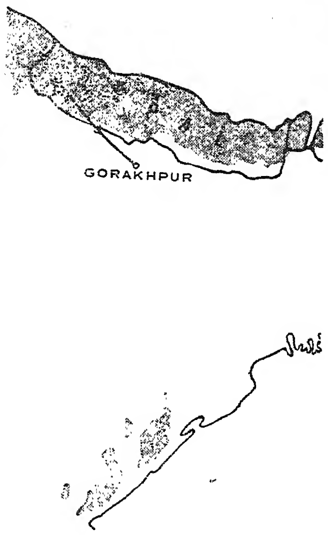
Date of rust appearance ... ... February 15, 1937.

D—The wind was traceable from Kashmir and passed over Gurudaspur where brown rust had appeared on December 4, 1936.

MAP NO. 65



MAP NO. 66



MAP NO. 67

65. GORAKHPUR (257 ft. above sea level). BROWN RUST. ORIGINAL MAP No. 1,648.

Date and heights of trajectories in feet	...	December 4, 1936 : A—1640, B—3280, C—4920.
Dates of spore shower soon after the winds	...	December 5—8.
Dates of spore shower 14—10 days before rust appearance	...	No spores were caught.
Date of rust appearance ...	...	No information (0—10 per cent crop infection on January 5/6, 1937).

A, B & C—The winds were traceable from central Nepal where 10 per cent crop infection with brown rust was observed on December 6.

66. GORAKHPUR (257 ft. above sea level). BROWN RUST. ORIGINAL MAP No. 1,647.

Date and height of trajectory in feet	...	December 3, 1936 : D—6560.
Dates of spore shower soon after the wind	...	December 5—8.
Dates of spore shower 14—10 days before rust appearance	...	No spores were caught.
Date of rust appearance ...	...	No information (0—10 per cent crop infection on January 5/6, 1937).

D—The wind was traceable from western Nepal and passed through central Nepal where 10 per cent crop infection with brown rust was observed on December 6, 1936.

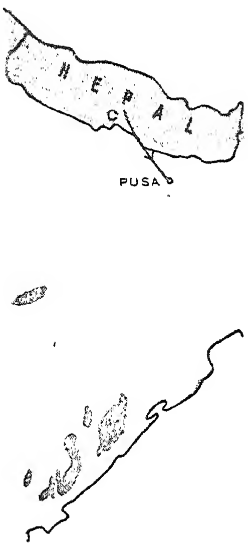
67. PUSA (188 ft. above sea level). BROWN RUST. ORIGINAL MAP No. 1,674.

Date and heights of trajectories in feet	...	December 13, 1936 : A—1640, B—3280, D—6560.
Dates of spore shower	...	December 11—15.**
Dates of spore showers 14—10 days before rust appearance	...	December 22—25 & 25—29.
Date of rust appearance ...	...	January 5, 1937.

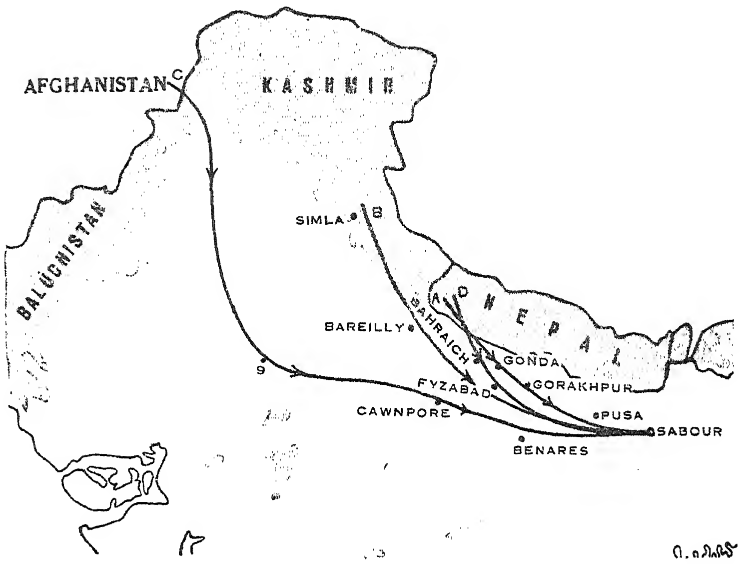
A, B & D—The winds were traceable from central Nepal where 10 per cent crop infection with brown rust was observed on December 6, 1936.

** The spore shower might have occurred on December 11 or 12, due to some earlier wind.

MAP NO. 68



MAP NO. 69



68. PUSA (188 ft. above sea level). BROWN RUST. ORIGINAL MAP No. 1,681.

Date and height of trajectory in feet ... December 20, 1936 : C—4920.

Dates of spore showers soon after the winds ... December 22—25 & 25—29.

Dates of spore shower 14—10 days before rust appearance ... ... December 22—25 & 25—29.

Date of rust appearance ... ... January 5.

C—The wind was traceable from central Nepal where 10 per cent crop infection with brown rust was observed on December 6, 1936.

69. SABOUR (122 ft. above sea level). BROWN RUST. ORIGINAL MAP Nos. 776 & 777.

Date and heights of trajectories in feet ... February 10, 1935 : A—1640,
B—3280,
C—4920,
D—6560.

Dates of spore showers soon after the winds ... February 11—14 & 14—18.

Dates of spore shower 14—10 days before rust appearance ... ... February 14—18.

Date of rust appearance ... ... February 28, 1935.

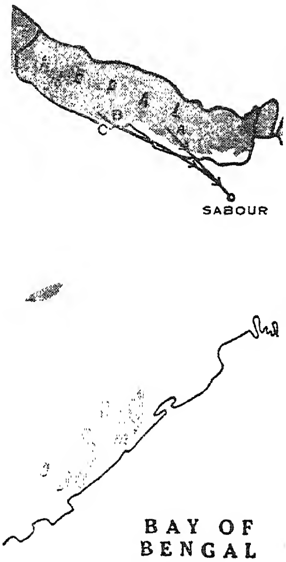
A—The wind was traceable from western Nepal where brown rust was found in traces on December 7, 1934 and passed near Bahraich, Gonda, Fyzabad and Gorakhpur where this rust had appeared before January 15, 1935.

B—The wind was traceable from Simla hills and passed near Simla, Bareilly and Fyzabad where brown rust had appeared by January 19, 1935.

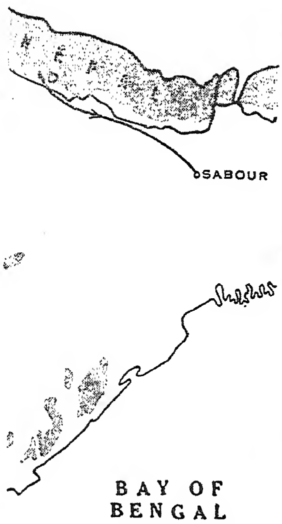
C—The wind was traceable from Afghanistan and passed over Cawnpore where 90—100 per cent crop infection was found on February 19 and near Benares where it was found in traces on January 12.

D—The wind was traceable from western Nepal and passed near Bahraich, over Gonda, Gorakhpur and near Pusa where brown rust had appeared before January 2, 1935.

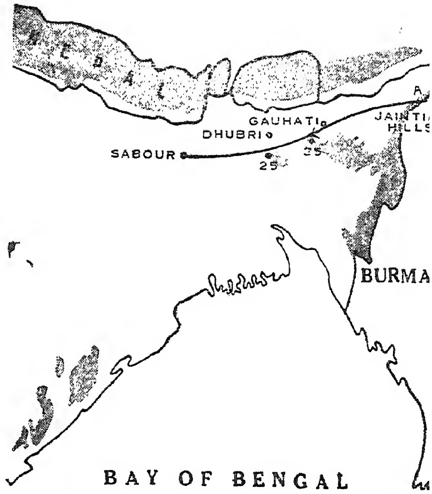
MAP NO. 70



MAP NO. 71



MAP NO. 72



70. SABOUR (122 ft. above sea level). BROWN RUST. ORIGINAL MAP No. 1,711.

Date and heights of trajectories in feet	...	December 10, 1936 : A—1640, B—3280, C—4920.
Dates of spore shower	...	No spores were caught till January 10—14.
Date of rust appearance ...	...	Early in January 1937.

A, B & C—The winds were traceable from central Nepal where 10 per cent crop infection was observed on December 6, 1936.

71. SABOUR (122 ft. above sea level). BROWN RUST. ORIGINAL MAP No. 1,712.

Date and height of trajectory in feet	...	December 11, 1936 : D—6560.
Dates of spore shower	...	No spores were caught till January 10—14.
Date of rust appearance ...	...	Early in January 1937.

D—The wind was traceable from central Nepal where 10 per cent crop infection was observed on December 6, 1936.

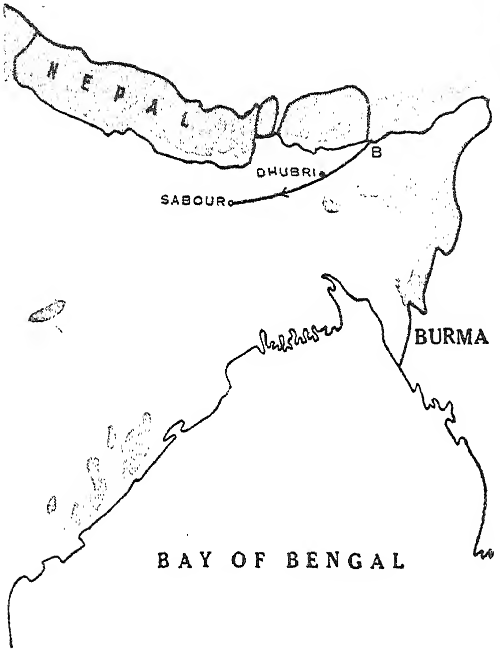
72. SABOUR (122 ft. above sea level). BROWN RUST. ORIGINAL MAP No. 2,288.

Date and height of trajectory in feet	...	January 26, 1938 : A—1640.
Dates of spore shower	...	January 23—27.**
Dates of spore shower 14—10 days before rust appearance	...	No spores were caught.
Date of rust appearance ...	...	February end of second week.

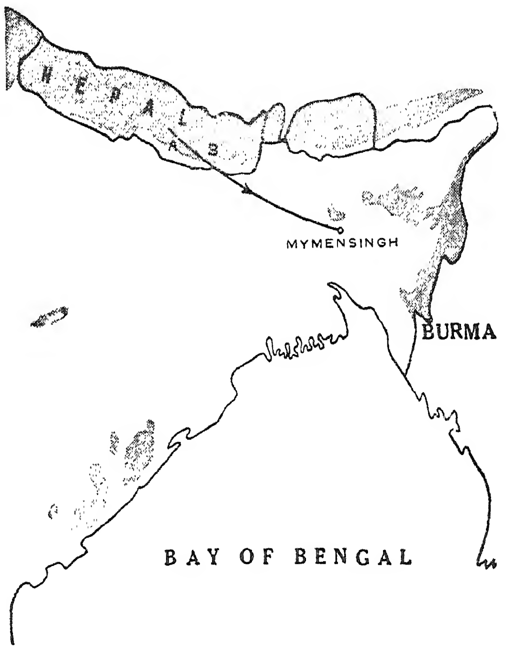
A—The wind was traceable from Jaintia hills in Assam and passed over Gauhati and near Dhubri where up to 100 per cent and up to 25 per cent crop infection with brown rust was observed on February 7 and January 18—19, 1938 respectively.

** The spore shower might have occurred on January 23, 24 or 25, due to some earlier wind.

MAP NO. 73



MAPS NOS. 74 & 75



73. SABOUR (122 ft. above sea level). BROWN RUST. ORIGINAL MAP No. 2,287.

Date and height of trajectory in feet ... January 25, 1938 : B—3280.

Dates of spore shower ... ... January 23—27‡.

Dates of spore shower 14—10 days before rust appearance ... ... No spores were caught.

Date of rust appearance ... ... February end of second week.

B—The wind was traceable from east of Bhutan and passed over Dhubri where up-to 25 per cent crop infection with brown rust was observed on January 18—19, 1938.

‡The spore shower might have occurred on January 23 or 24, due to some earlier wind.

74 & 75. MYMENSINGH (62 ft. above sea level). BROWN RUST. ORIGINAL MAP Nos. 1,745 & 1,746.

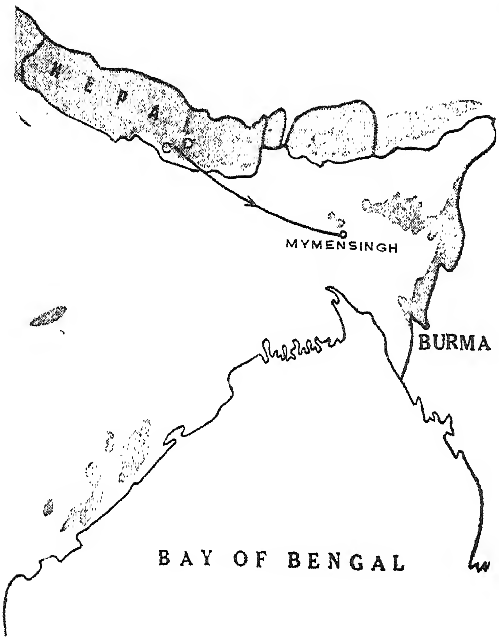
Dates and heights of trajectories in feet ... December 22 & 23, 1936 : A—1640, B—3280.

Dates of spore shower ... ... No slides were exposed.

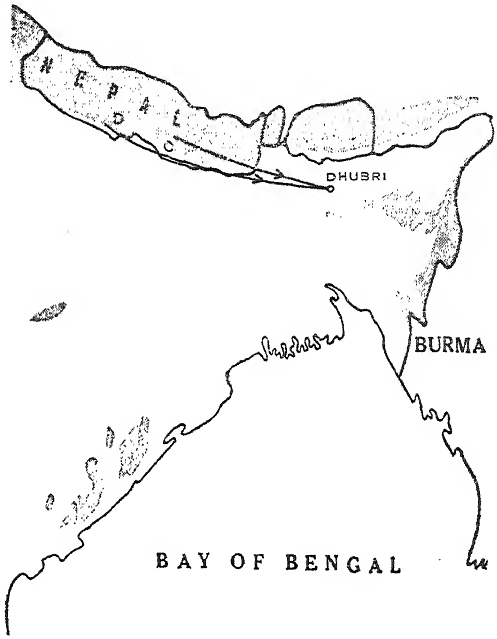
Date of rust appearance ... ... Did not appear (Traces—75 per cent crop infection on February 13, 1937).

A & B—The winds were traceable from central Nepal where 10 per cent crop infection was observed on December 6, 1936.

MAPS NOS. 76 & 77



MAP NO. 78



76 & 77. MYMENSINGH (62 ft. above sea level). ORIGINAL MAP Nos. 1,739 & 1,740.

Dates and heights of trajectories in feet ... December 16 & 17, 1936 : C—4920, D—6560.

Dates of spore shower ... ... No slides were exposed.

Date of rust appearance ... ... Did not appear (Traces—75 per cent crop infection on February 13, 1937).

C & D—The winds were traceable from central Nepal where 10 per cent crop infection was observed on December 6, 1936.

78. DHUBRI (115 ft. above sea level). ORIGINAL MAP No. 1,784.

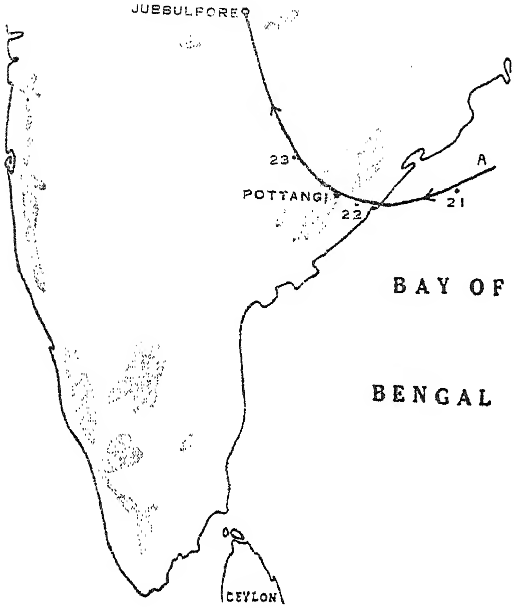
Date and heights of trajectories in feet ... December 16, 1936 : C—4920, D—6560.

Dates of spore shower ... ... No slides were exposed.

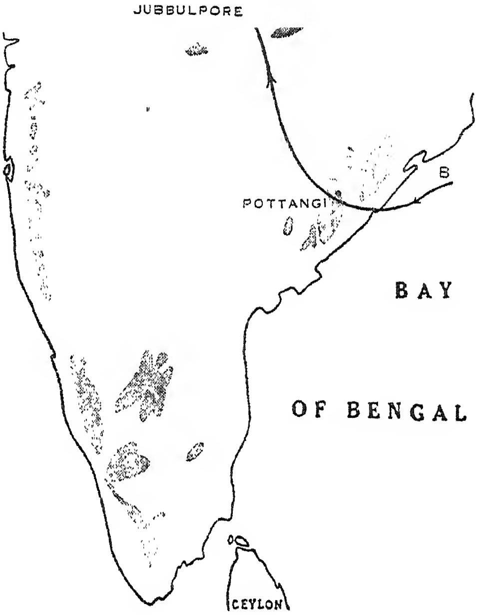
Date of rust appearance ... ... (On January 23, 0—40 per cent crop infection was observed).

C & D—The winds were traceable from central Nepal where 10 per cent crop infection with brown rust was observed on December 6, 1936.

MAP NO. 79



MAP NO. 80



79. JUBBULPORE (1,289 ft. above sea level). BROWN RUST. ORIGINAL MAP No. 917.

Date and height of trajectory in feet ... January 24, 1935 : A—1640.

Dates of spore shower soon after the wind ... January 24—27.

Dates of spore shower 14—10 days before rust appearance ... ... February 3—7.

Date of rust appearance ... ... February 17, 1935.

A—The wind entered the country on January 21 and passed over Pottangi where up to 100 per cent crop infection with brown rust was observed on January 8—9, 1935.

80. JUBBULPORE (1,289 ft. above sea level). BROWN RUST. ORIGINAL MAP No. 914.

Date and height of trajectory in feet ... January 27, 1935 : B—3280.

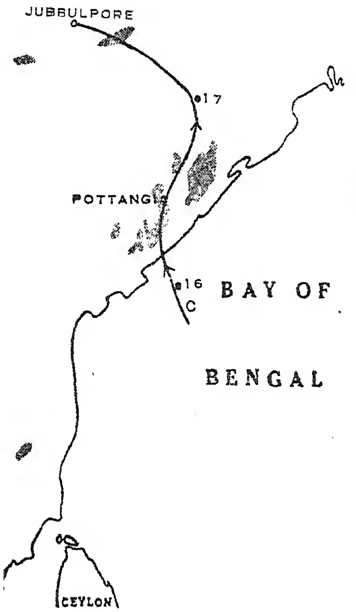
Dates of spore showers soon after the wind ... No spores were caught.

Dates of spore shower 14—10 days before rust appearance ... ... February 3—7.

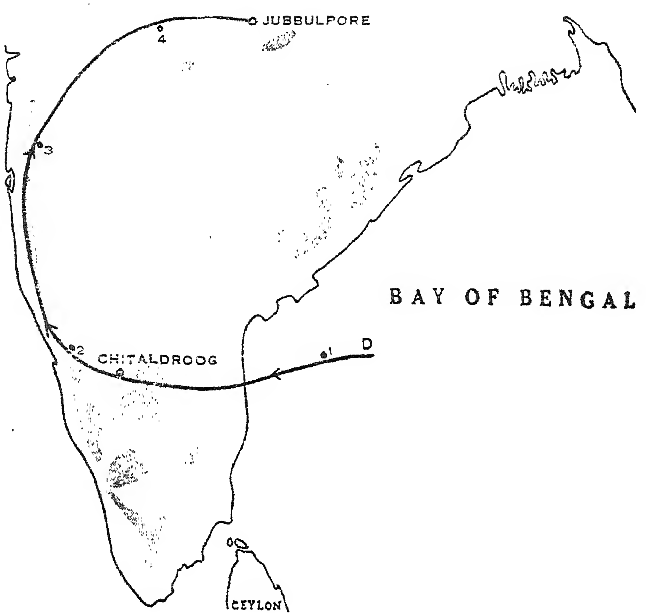
Date of rust appearance ... ... February 17, 1935.

B—The wind entered the country on January 25 and passed near Pottangi where up to 100 per cent crop infection with brown rust was observed on January 8—9, 1935.

MAP NO. 81



MAP NO. 82



81. JUBBULPORE (1,289 ft. above sea level). BROWN RUST. ORIGINAL MAP No. 878.

Date and height of trajectory in feet ... January 18, 1935 : C—4920.

Dates of spore shower soon after the wind ... January 21—24.

Dates of spore shower 14—10 days before rust appearance ... ... February 3—7.

Date of rust appearance ... ... February 17, 1935.

C—The wind entered the country on January 16 and passed over Pottangi where up to 100 per cent crop infection with brown rust was observed on January 8—9, 1935.

82. JUBBULPORE (1,289 ft. above sea level). BROWN RUST. ORIGINAL MAP No. 385.

Date and height of trajectory in feet ... January 5, 1934 : D—6560.

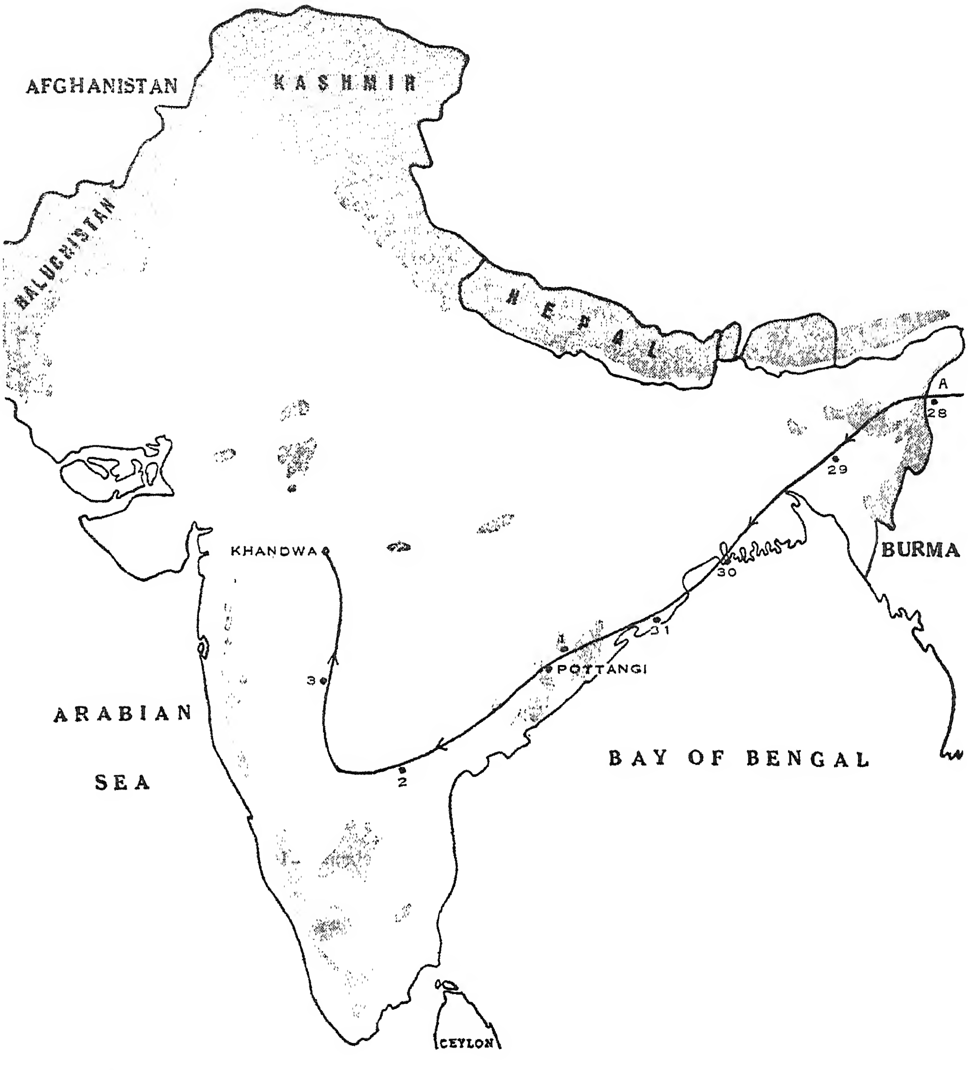
Dates of spore shower soon after the wind ... January 6—10.

Dates of spore shower 14—10 days before rust appearance ... ... January 17—20.

Date of rust appearance ... ... January 30, 1934.

D—The wind entered the country from the Bay of Bengal on January 1 and passed over Chitaldroog where over 60 per cent crop infection with brown rust was observed on December 15, 1933.

MAP NO. 83



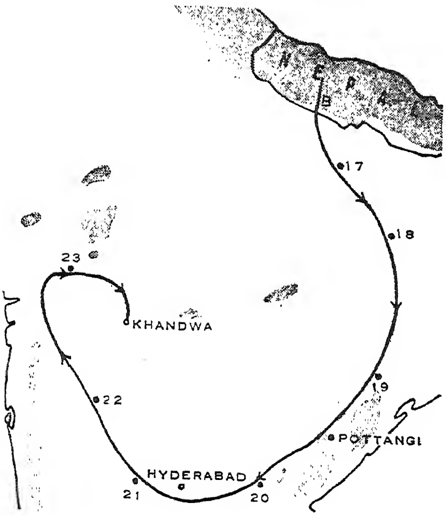
83. KHANDWA (1,044 ft. above sea level). BROWN RUST. ORIGINAL MAP No. 338.

Date and height of trajectory in feet ...	January 4, 1934 : A—1640.
Dates of spore showers	January 2—6** & 6—9.
Dates of spore shower 14—10 days before rust appearance	January 9—13.
Date of rust appearance	January 24, 1934.

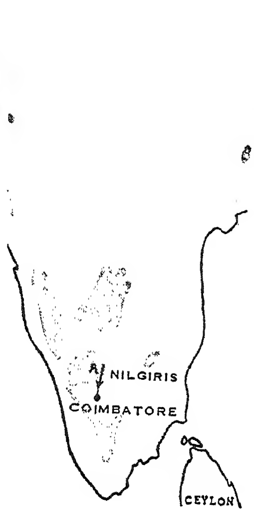
A—The wind was traceable from Burma and passed over Pottangi on January 1, 1934, where 100 per cent crop infection was observed on January 13—14.

**The spore shower might have occurred on January 2 or 3, due to some earlier wind.

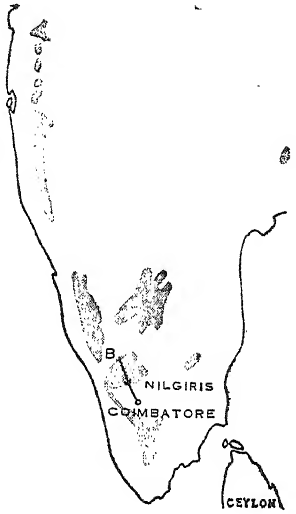
MAP NO. 84



MAP NO. 85



MAP NO. 86



84. KHANDWA (1,044 ft. above sea level). BROWN RUST. ORIGINAL MAP No. 432.

Date and height of trajectory in feet ... December 24, 1933 : B—3280.

Dates of spore shower ... ... December 22—25‡.

Dates of spore shower 14—10 days before rust appearance ... ... January 9—13.

Date of rust appearance ... ... January 24, 1934.

B—The wind was traceable from western Nepal and passed near Pottangi on December 19, where 100 per cent crop infection was observed on January 13—14, 1934.

‡The spore shower might have occurred on December 22 or 23, due to some earlier wind.

85. COIMBATORE (1,341 ft. above sea level). BROWN RUST. ORIGINAL MAP No. 1,322.

Date and height of trajectory in feet ... November 12, 1935 : A—1640.

Dates of spore showers soon after the wind ... November 12—15 & 15—19.

Dates of spore shower 14—10 days before rust appearance ... ... November 22—26.

Date of rust appearance ... ... December 9, 1935.

A—The wind was traceable from Nilgiris where 65—100 per cent crop infection with brown rust was observed on September 20, 1935.

86. COIMBATORE (1,341 ft. above sea level). BROWN RUST. ORIGINAL MAP No. 1,459.

Date and height of trajectory in feet ... November 14, 1935 : B—3280.

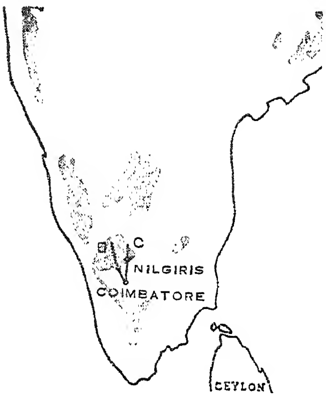
Dates of spore showers soon after the wind ... November 15—19.

Dates of spore shower 14—10 days before rust appearance ... ... November 22—26.

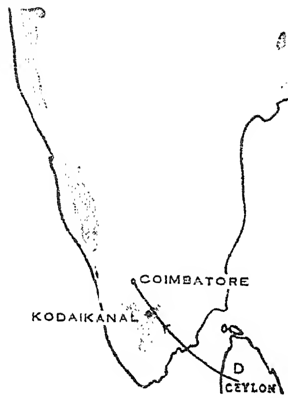
Date of rust appearance ... ... December 9, 1935.

B—The wind was traceable from Nilgiris where 65—100 per cent crop infection with brown rust was observed on September 20, 1935.

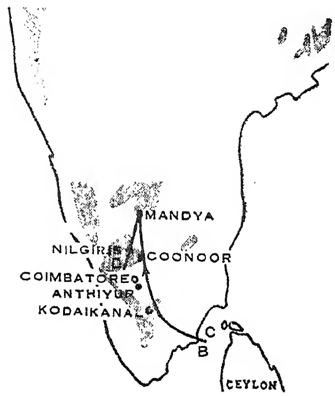
MAP NO. 87



MAP NO. 88



MAP NO. 89



87. COIMBATORE (1,341 ft. above sea level). BROWN RUST. ORIGINAL MAP No. 1,458.

Date and heights of trajectories in feet ... November 13, 1935 : C—4920, D—6560.

Dates of spore shower soon after the winds ... November 15—19.

Dates of spore shower 14—10 days before rust appearance ... ... November 22—26.

Date of rust appearance ... ... December 9, 1935.

C & D—The winds were traceable from Nilgiris where 65—100 per cent crop infection with brown rust was observed on September 20, 1935.

88. COIMBATORE (1,341 ft. above sea level). BROWN RUST. ORIGINAL MAP No. 1,323.

Date and height of trajectory in feet ... November 17, 1935 : D—6560.

Dates of spore shower soon after the wind ... November 22—26.

Dates of spore shower 14—10 days before rust appearance ... ... November 22—26.

Date of rust appearance ... ... December 9, 1935.

D—The wind was traceable from Ceylon and passed near Kodaikanal where up to 40 per cent crop infection was observed on September 28, 1935.

89. MANDYA (2,580 ft. above sea level). BROWN RUST. ORIGINAL MAP No. 1,954.

Date and heights of trajectories in fees ... March 2, 1937 : B—3280, C—4920, D—6560.

Dates of spore shower ... ... March 1—4‡.

Dates of spore shower 14—10 days before rust appearance ... ... March 1—4.

Date of rust appearance ... ... March 15, 1937.

B & C—The winds after entering the country passed near Kodaikanal where 40—60 per cent crop infection with brown rust was observed on October 10, 1936, near Anthiyur and Coimbatore where brown rust had appeared on February 13, 1937 and November 16, 1936 respectively and near Coonoor where 100 per cent crop infection was observed on September 28, 1936.

D—The wind was traceable from Nilgiris where 100 per cent crop infection was observed on September 28, 1936.

‡ The spore shower might have occurred on March 1, due to some earlier wind.

are of special interest, and for the reasons given before, some importance has to be attached also to winds from stations where the date of rust appearance, as reported by a local observer, was only fifteen days earlier.

As with black rust, for some of the stations no winds could be interpreted as 'relevant' in relation to a place or places where rust had appeared earlier although spore showers occurred 4 to 2 weeks before local outbreaks. By way of illustration detailed information for three stations is supplied below :—

(*a*) *Karnal, 900 feet above sea level* (*Punjab*). For this station no 'relevant' winds were found during 1935 to 1938 although during the first two years spore showers took place, 4 to 2 weeks before rust appearance.

In 1935-36 brown rust appeared on January 19 and there were spore showers on December 26 to 30 and January 2 to 6. Wind-trajectories were studied for December 19 to January 2. None of the winds came from or passed over a place where rust had appeared even 15 days earlier and no information was available from the other stations over which the winds had passed. As shown in Table XIV, there were 16 winds that year from the hills which for the reasons already given in Part One were regarded as 'possibly relevant'. Winds of January 2 are reproduced on Map No. 90.

In 1936-37 rust broke out on January 22. Spore showers occurred on December 28 to 31 and January 4 to 7. Wind-trajectories were studied for December 22 to January 6. None of the winds passed over a station wherefrom this rust had been reported earlier and no information was available for others. Winds of January 3 are reproduced on Map No. 91. None of the winds referred to above could be regarded as 'relevant'. However, 30 winds from the Siwalik range and the neighbourhood of Simla could be interpreted as 'possibly relevant' for the reasons given in Part One. Such winds have been included in Tables XIV and XV.

In 1937-38 rust appeared on February 13 but no spores could be detected on aeroscope-slides before February 10 to 14. Trajectories were studied for January 13 to 28 but none of the winds could be interpreted as 'relevant' although there were 24 'possibly relevant' winds that year as shown in Table XIV.

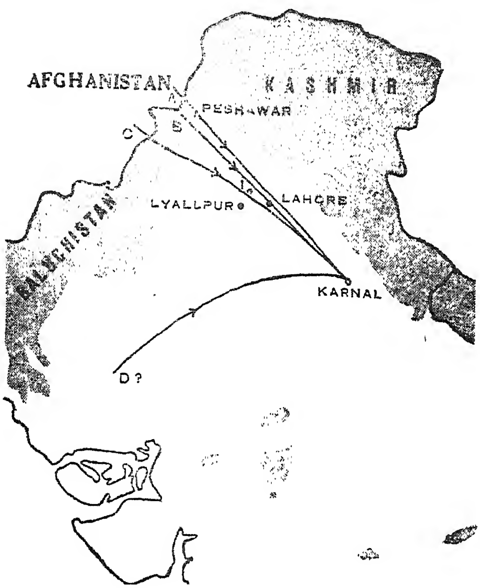
(*b*) *Agra, 554 feet above sea level* (*United Provinces*). For this station no 'relevant' winds were found for 1932-33, 1935-36 and 1937-38 although during the first two years spore showers occurred 4 to 2 weeks before rust appearance.

In 1932-33 rust appeared on February 19 and the only spore shower 4 to 2 weeks before rust appearance was that of February 4 to 7. Trajectories were studied for January 20 to February 4 but none of the winds passed over a station where rust had appeared even 15 days earlier, and for other stations there was no information. For this station there were 22 'possibly relevant' winds that year as shown in Table XIV. Winds of February 4 are reproduced on Map No. 92 but none of them could be considered as 'relevant'.

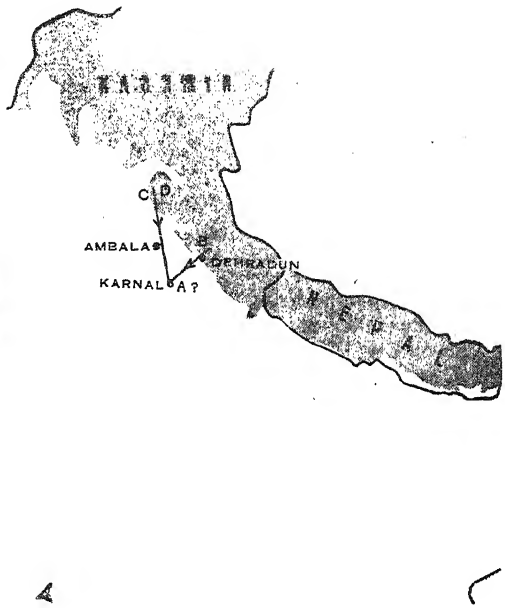
In 1935-36 rust appeared on February 5 and there were spore showers on January 4 to 10. Trajectories were studied for January 5 to 19 but no wind was found to be 'relevant'. However, there were 12 'possibly relevant' winds that year. Winds of January 7 are reproduced on Map No. 93.

In 1937-38 rust appeared on February 3 although no spores could be detected on aeroscope-slides nor was any wind found to be 'relevant' but there were 13 'possibly relevant' winds that year.

MAP NO. 90



MAP NO. 91



90. KARNAL (900 ft. above sea level). BROWN RUST. ORIGINAL MAP Nos. 1,139 & 1,140.

Date and heights of trajectories in feet ... January 2, 1936 : A—1640, B—3280, C—4920, D—6560.

Dates of spore shower soon after the winds ... January 2—6.

Dates of spore shower 14—10 days before rust appearance ... ... January 2—6 & 6—9.

Date of rust appearance ... ... January 19, 1936.

A—Traceable from Afghanistan and passed over Peshawar and near Lahore.

B—Traceable from N.-W. F. Province and passed near Peshawar and over Lahore.

C—Traceable from Afghanistan and passed near Lyallpur and Lahore.

D—Traceable from Sind and passed over Rajputana.

Brown rust appeared at Lyallpur on March 27.

91. KARNAL (900 ft. above sea level). BROWN RUST. ORIGINAL MAP No. 1,751.

Date and heights of trajectories in feet ... January 3, 1937 : A—1640, B—3280, C—4920, D—6560.

Dates of spore shower soon after the winds ... January 4—7.

Dates of spore shower 14—10 days before rust appearance ... ... January 7—11.

Date of rust appearance ... ... January 22, 1937.

A—The wind was untraceable.

B—Traceable from Kumaon hills and passed over Dehradun.

C & D—Traceable from Simla hills and passed near Ambala.

At Dehradun up to 65 per cent crop infection with brown rust was observed on February 23.

MAP NO. 92

MAP NO. 93

92. AGRA (554 ft. above sea level). BROWN RUST. ORIGINAL MAP No. 69.

Date and heights of trajectories in feet ... February 4, 1933 : A—1640, B—3280, C—4920, D—6560.

Dates of spore shower soon after the winds ... February 4—7.

Dates of spore shower 14—10 days before rust appearance ... ... February 4—7.

Date of rust appearance ... ... February 19, 1933.

A, B, C & D—The winds were traceable from Sulaiman range and passed over Punjab and Rajputana.

93. AGRA (554 ft. above sea level). ORIGINAL MAP Nos. 1,149 & 1,150.

Date and heights of trajectories in feet ... January 7, 1936 : A—1640, B—3280, C—4920, D—6560.

Dates of spore shower ... ... January 6—8** & 8—10.

Dates of spore shower 14—10 days before rust appearance ... ... No spores were caught.

Date of rust appearance ... ... February 5, 1936.

A—The wind was traceable from Siwalik range and passed over Simla and Dehradun.

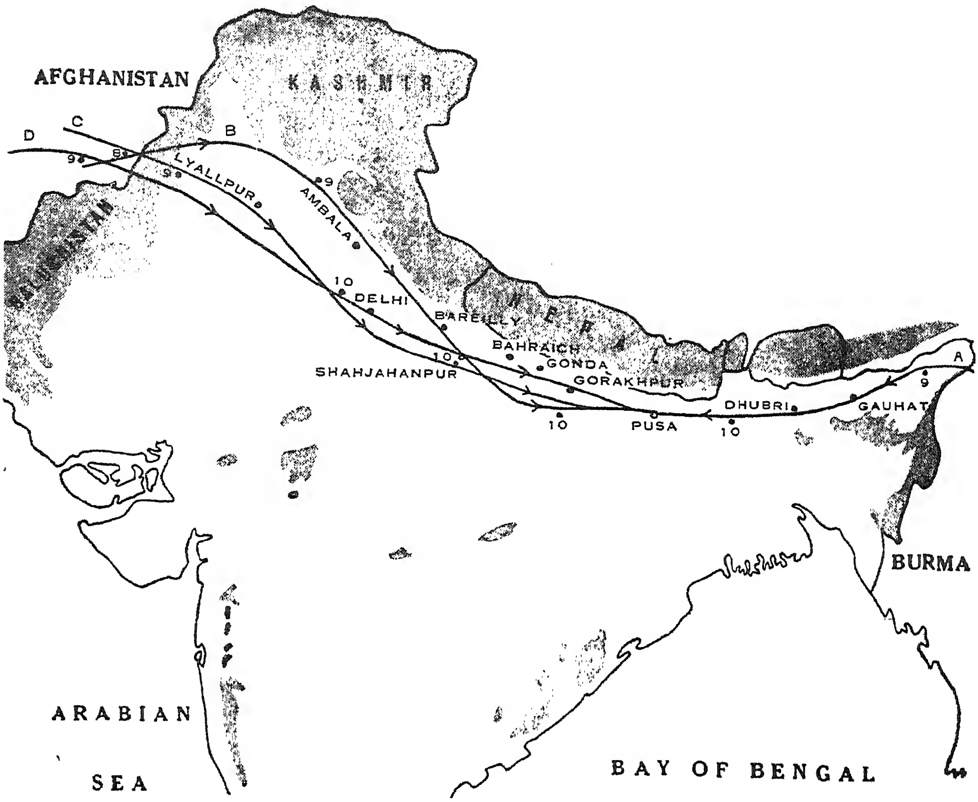
B—The wind was traceable from N.-W. F. Province and passed near Lyallpur.

C & D—The winds were traceable from Baluchistan and passed over Sind and Rajputana.

Brown rust appeared at Simla on April 10, at Lyallpur on March 27 and it was observed in traces at Dehradun on March 18.

** The spore shower might have occurred on January 6, due to some earlier wind.

MAP NO. 94



94. PUSA (188 ft. above sea level). BROWN RUST. ORIGINAL MAP Nos. 951 & 952.

Date and heights of trajectories in feet ... November 11, 1934 : A—1640,
B—3280,
C—4920,
D—6560.

Dates of spore shower soon after the winds ... November 12—15.

Dates of spore shower 14—10 days before rust appearance ... ... No spores were caught.

Date of rust appearance ... ... December 9, 1934.

A—Traceable from Burma and passed near Gauhati and Dhubri.

B—Traceable from Afghanistan and passed near Ambala, Bareilly and Shahjahanpur.

C—Traceable from Afghanistan and passed near Lyallpur, Delhi and Gorakhpur.

D—Traceable from Afghanistan and passed over Delhi and Shahjahanpur, near Bahraich, Gonda and Gorakhpur.

Brown rust appeared at Shahjahanpur on February 11, at Lyallpur on March 15 and it was observed in traces on January 19 at Bareilly and 40—50 per cent crop infection was found at Gorakhpur on December 31.

(c) *Pusa, 188 feet above sea level (Bihar).* No 'relevant' winds were found for this station in 1932-33, 1934-35 and 1937-38 but during the first two years spore showers occurred 4 to 2 weeks before rust appearance.

In 1932-33 rust appeared on December 29 and spore showers occurred on December 1 to 5 and 15 to 19. Trajectories were studied for November 30 to December 14, but none of the winds had passed over a station wherefrom this rust had been reported even 15 days earlier. However, 22 winds were found to be 'possibly relevant'.

In 1934-35 rust appeared on December 9 and there were spore showers from November 5 to 8, 8 to 12 and 12 to 15. Trajectories were studied for November 9 to 24 but none of the winds was found to be 'relevant' although there were 20 'possibly relevant' winds that year. Winds of November 11 are reproduced on Map No. 94.

In 1937-38 rust appeared on January 9 but no spores were detected on any of the aeroscope-slides before January 13 to 16, i.e. 4 to 7 days after rust appearance. Trajectories were studied for December 9 to 24 but none of the winds could be interpreted as 'relevant' although there were as many as 42 'possibly relevant' winds that year.

A summary of data supplied in Map Nos. 90 to 94 is given in Table XVI.

As stated in Part Two, the writer is fully aware of a large number of misfits which are difficult to explain. At the same time, it is clear from Table XIV that spore showers occurred at a large number of stations for which no wind could be interpreted as 'relevant'. It is likely, therefore, that the inoculum was brought to such stations by 'possibly relevant' winds that blew during the intervals between the daily meteorological observations. As stated before, up to the end of February 1937, the working charts generally gave information regarding morning winds only and no information was available about wind direction between one morning and the next until March 1937. It is also likely that the inoculum came from places of earlier outbreaks, of which there may be many, wherefrom no information was available regarding the dates of rust appearance. Spore showers, if any, following such winds as were traced back to the hills in the Working Charts of the Meteorological Department and therefore interpreted as 'possibly relevant,' are shown in Table XIV.

(iii) *Stations of earlier rust appearance in the plains*

In addition to the stations selected for the exposure of aeroscope-slides, the first appearance of brown rust has been studied at a large number of places in the plains. Information regarding the earliest and usual dates of appearance of brown rust at representative stations is given in Table XVII in which foot-hill stations are marked with an asterisk.

It is clear from this Table that in general brown rust, like the black rust, breaks out much earlier in the foot-hills than in the neighbouring plains.

The scrutiny of data regarding dissemination of brown rust during 1938-40 has recently been completed. For Agra there was one 'relevant' and 14 'possibly relevant' winds in 1938-39 but in the following year no wind was found to be 'relevant' although eight winds were regarded 'possibly relevant'. For Pusa there was no 'relevant' wind in either of the years but 53 winds in 1938-39 and 35 in the following year were found to be 'possibly relevant.' Karnal was not included in the list of stations selected for the study of rust dissemination during this period.

Detailed information about trajectories for Agra and Pusa along with those for other stations will be supplied in a subsequent article.

(*a*) *Early outbreaks due to nearness to hills.* The observations made in Part Two about black rust apply to this rust also.

(*b*) *Early outbreaks due to early crops in the plains.* It has been found that in Peninsular India brown rust breaks out much earlier at those stations where there is an early crop. At Chitaldroog it was found as early as November 30 in 1934 on wheat sown in August. In 1935 it broke out on October 16 at Mandya in the miniature plot, sown at the request of the writer in August. At Coimbatore it appeared still earlier, i.e. September 28, in 1937 on wheat sown in miniature plots during June-July. As stated in Part Two, wheat is sown in the districts of Chitaldroog and Bellary in July-August as well as in October. This rust has not been reported from or observed at Bellary, possibly due to warmer weather than at Chitaldroog (2,405 feet above sea level), Mandya (2,580 feet above sea level) and Coimbatore (1,340 feet above sea level). The last two places are situated at the foot of the Nilgiris on the north and south respectively.

It is evident that places such as Chitaldroog would act as secondary foci because of the early crop.

(*iv*) *Winds in relation to initial rust outbreaks*

As with black rust, there was at least one 'relevant' or 'possibly relevant' wind for most of the stations under study as will be clear from the table given below. In 59 records of rust appearance spore showers took place in 32 soon after the 'relevant' or 'possibly relevant' winds. Spore showers also occurred prior to 6 other records of rust appearance but they could not be attributed to any 'relevant' or 'possibly relevant' wind. In all these cases spores were caught nearly 4 to 2 weeks before rust appearance. No information could be obtained regarding spore showers in two cases because slides were not exposed at two stations. Of the remaining 19 records, spores were caught only 14 to 10 days or so before rust appearance in two but no spores were detected in others. A general summary of data regarding spore showers in relation to winds and records of rust appearance is given in Part Five, General Discussion and Conclusions.

Year	Number of stations for which trajectories were studied	Number of stations for which there was at least one 'relevant' or 'possibly relevant' wind		Number of stations for which there was no 'relevant' or 'possibly relevant' wind
		Relevant	Possibly relevant only	
1932-33	4	1	3	0
1933-34	13	9	2	2
1934-35	11	8	2	1
1935-36	10	5	3	2
1936-37	13	12	1	0
1937-38	8	3	5	0

(v) *Probable foci of infection*

Oversummering of this rust in the uredostage in the hills of India has been fully discussed in the previous monograph [Mehta, 1940]. It oversummers only at altitudes slightly higher than those where black rust is able to survive during the hottest part of the year. Well-advanced infection by this rust on the August-September crop in central Nepal has been observed several times as early as the first week of December. Similarly, by August-September there is abundance of rust in the Nilgiris as well as the Palnis every year on the first crop, sown in April to August. Reference has already been made to its outbreak during September-October in the foot-hills of the Nilgiris in miniature plots sown 'out of season'.

Survival of this rust during summer takes place over a considerable part of the Himalayan range above altitudes of about 4,500 ft., and the same applies to the Nilgiris and the Palni hills where on account of two crops it is found in abundance during the greater part of the year.

Consequently, there are several foci, the two most serious being those in central Nepal, Nilgiris and the Palnis, due to early crops.

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TAB X

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Year	Period of exposure	Dates of first spore shower. Number of spores in brackets	Dates of spore shower, if any, 4 to 2 weeks before rust appearance. Number of spores in brackets	Date of rust appearance, as reported from the station	Date of observation, *if any, regarding incidence of rust
			PUNJAB		
			1. Lyallpur		
1929-30	January 4—March 30 ...	January 4—8 (2)	January 4—8 (2)	January 3rd week	
1930-31	January 10—April 10 ...	No spores	...	No information	
1931-32	November 21—April 5 ...	January 9—13 (2)	February 20—24 (2)	March 11	
1932-33	November 27—April 4 ...	March 29—April 1 (3)	March 29—April 1 (3)	Middle of April	
1933-34	November 1—March 24 ...	December 9—13 (1)	February 16—20 (2)	March 1st week	
1934-35	November 1—April 1 ...	February 18—21 (1)	February 18—21 (1)	March 15	March 22 (traces)
1935-36	November 2—April 7 ...	February 15—18 (1)	March 6—10 (35)	March 27	
1936-37	December 3—April 15 ...	January 21—25 (4)	March 1—4 (1)	March 20	
1937-38	December 1—March 31 ...	No spores ...	No spores ...	April 1	
			2. Gurdaspur		
1931-32	November 15—March 15	No spores	...	No information	
1932-33	December 2—February 5	January 12—16 (1)	...† ...	No rust	March 21 (traces)
1933-34	November 3—February 26	December 8—12 (1)	February 24—26 (2)	March 18	

TABLE X—*Con*.

Year	Period of exposure	Dates of first spore shower. Number of spores in brackets	Dates of spore shower, if any, 4 to 2 weeks before rust appearance. Number of spores in brackets	Date of rust appearance, as reported from the station	Date of observation, *if any, regarding incidence of rust
			2. Gurdaspur—*Contd.*		
1934-35	November 1—April 1 ...	March 12—16 (1)	March 12—16 (1)	April 5	
1935-36	November 1—April 2 ...	December 3—5 (1)	...	No rust	
1936-37	November 20—April 14 ...	November 8—10 (1)	November 8—10 (1)	December 4	
1937-38	December 1—April 13 ...	No spores	...	No information	
			3. Rupar		
1931-32	November 25—March 4 ...	No spores	...	No information	
1932-33	January 1—10 ...	No spores	...	No information	
1933-34	January 17—February 1 ...	January 29—February 1 (4)	...	No information	
1935-36	November 15—March 27	February 18—21 (1)	...	No information	
1936-37	November 20—March 26	February 5—9 (2)	...	No rust	
1937-38	December 6—March 11 ...	January 14—17 (1)	...	No information	

TABLE d

Year	Period of exposure	Dates of first spore shower. Number of spores in brackets	Dates of spore shower, if any, 4 to 2 weeks before rust appearance. Number of spores in brackets	Date of rust appearance, as reported from the station	Date of observation, if any, regarding incidence of rust
			4. Hoshiarpur		
1931-32	November 17—March 16	February 9—12 (1)	...	No information	
1932-33	January 14—April 3 ...	March 19—23 (1)	No spores	No information ...	March 22 (traces)
1933-34	November 1—February 6	November 18—21 (1)	No spores	January 1st week	
1934-35	November 5—March 26 ...	January 5—8 (1)	January 14—17 (2)	February 1st half ...	March 18 (traces)
1935-36	November 1—April 8 ...	No spores	No spores ...	February 1st half	
1936-37	November 18—April 4 ...	January 5—8 (1)	No spores (January 5—8) (*) (1)	January 15	
1937-38	December 1—March 31 ...	March 18—21 (5)	No spores	No information ...	March 13 (0-10 per cent)
			5. Rawalpindi		
1932-33	September 15—March 26	March 5—9 (1)	No spores	April 2nd week	
1933-34	January 21—April 18 ...	March 18—22 (2)	April 1—5 (120)	April 19	
1934-35	November 23—April 1 ...	February 4—8 (1)	No spores ...	March 3rd week ...	March 24 (traces)
1935-36	November 8—April 3 ...	February 17—21 (1)	...	No rust	
1936-37	January 1—April 20 ...	February 24—27 (2)	...	No rust	
1937-38	December 15—April 25 ...	January 17—21 (1)	...	No information	

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TABLE X- ontd

Year	Period of exposure	Dates of first spore shower. Number of spores in brackets	Dates of spore shower, if any, 4 to 2 weeks before rust appearance. Number of spores in brackets	Date of rust appearance, as reported from the station	Date of observation, if any, regarding incidence of rust
			6. Simla† 7,000 feet above sea level		
1932-33	September 15—April 6 ...	October 5—9 (3)	No spores ...	March 9	
1933-34	November 1—February 24	November 8—15 (1)	No spores	November 15	
1934-35	July 3—April 24 ...	August 8—12 (1)	December 19—22 (6)	January 18	
1935-36	November 1—April 4 ...	February 29—March 3 (3)	March 18—23 (3)	April 10	
1936-37	October 3—April 14 ...	October 17—21 (5)	February 27—March 3 (1)	March 20	
1937-38	November 1—May 23 ...	January 24—27 (1)	March 28—31 (1)	April 19	
			7. Khanewal		
1933-34	December 3—March 7 ...	February 11—14 (1)	February 14—18 (1)	March 12	
1934-35	November 1—April 2 ...	February 24—27 (2)	February 24—27 (2)	March 23	March 23 (traces)
1935-36	November 7—April 5 ...	January 5—8 (1)	February 5—9 (1)	February 24	
1936-37	January 1—April 7 ...	No spores	...	No rust	
1937-38	December 4—April 3 ...	No spores	...	No information	

TABLE X- :ontd.

Year	Period of exposure	Dates of first spore shower. Number of spores in brackets	Dates of spore shower, if any, 4 to 2 weeks before rust appearance. Number of spores in brackets	Date of rust appearance, as reported from the station	Date of observation, if any, regarding incidence of rust
			8. Karnal		
1933-34	October 15—March 3 ...	October 29—November 1 (1)	No spores	January 15	
1934-35	October 15—March 14 ...	No spores	...	February 26	March 16 (traces 80 per cent)
1935-36	October 15—March 16 ...	November 14—18 (1)	December 26—30 (2) January 2—6 (5)	January 19	March 20 (5-80 per cent)
1936-37	December 17—March 25	December 17—21 (1)	December 28—31 (1) January 4—7 (1)	January 22	
1937-38	December 2—April 7 ...	February 10—14 (6)	No spores	February 13	
			BALUCHISTAN		
			9. Quetta		
1932-33	September 15—May 8 ...	April 26—30 ... (1)	...	No innformation	
1933-34	March 23—April 12 ...	No spores	...	No information	
1935-36	November 5—December 16	No spores	...	No information	
1936-37	November 21—April 24 ...	February 16—20 (1)	No spores	April 30	
1937-38	January 15—May 23 ...	No spores	...	No information	

TABLE

Year	Period of exposure	Dates of first spore shower. Number of spores in brackets	Dates of spore shower, if any, 4 to 2 weeks before rust appearance. Number of spores in brackets	Date of rust appearance, as reported from the station	Date of observation, if any, regarding incidence of rust
			N.-W. F. PROVINCE		
			10. Peshawar (Tarnab Farm)		
1935-36	November 15—April 6 ...	No spores	No spores ...	January 2nd week	
1936-37	December 28—February 12	No spores	...	No rust ...	
1937-38	November 28—March 1...	No spores	...	No information	
			SIND		
			11. Karachi		
1932-33	September 8—December 22	No spores	...	No information	
			12. Sakrand		
1932-33	September 15—March 17	No spores	...	No informaton	
1933-34	December 11—March 15	February 13—17 (2)	February 13—17 (2)	March 10	
1934-35	November 5—April 4 ...	No spores	No spores	March 4	March 7 (traces)
1935-36	November 5—April 1 ...	February 1—4 (1)	February 25—28 (2)	March 13	
1936-37	December 3—March 25 ...	February 28—March 1 (1)	February 28—March 1 (1)	March 20	
1937-38	November 27—March 15	No spores	...	No information	

TABLE X *ontd.*

Year	Period of exposure	Dates of first spore shower. Number of spores in brackets	Dates of spore shower, if any, 4 to 2 weeks before rust appearance. Number of spores in brackets	Date of rust appearance, as reported from the station	Date of observation, if any, regarding incidence of rust
			DELHI		
		13. Delhi (Imperial Agricultural Research Institute)			
1936-37	November 17—March 15	January 26—29 (1)	January 26—29 (1) February 5—9, 9—12 (2, 8)	February 24 ...	February 27 (5-40 per cent)
1937-38	December 1—April 2 ...	March 6—9 (7)	No spores	February 15	March 20—21 (0-90 per cent)
			UNITED PROVINCES		
			14. Agra * (Bichpuri farm)		
1929-30	January 4—March 1 ...	January 25—29 (28)	No spores	January 29	
1930-31	December 31—February 21	January 24—31 (1)	No spores	January 18	
1931-32	November 28—March 15	January 20—23 (2)	January 20—23 (2)	February 2nd week	
1932-33	December 17—March 10	February 4—7 (	February 4—7 (1)	February 19	
1933-34	November 1—February 7	January 7—10 (1)	January 10—14 (1)	February 1	
1934-35	October 16—March 10 ...	January 27—30 (1)	No spores ...	February 2	
1935-36	October 18—February 1 ...	January 4—6 (1)	January 4—6 (1) January 6—8 (1) January 8—10 (1)	February 5	
1936-37	November 17—February 15	February 3—6 (2)	No spores February 3—6 (†) (2)	February 15	
1937-38	November 20—March 13	No spores	No spores	February 3	

Observati[illegible] rust appearance at Agra were made by th[illegible] te[illegible] members o[illegible] [illegible]rch staff.

[illegible]) Spore sh[illegible] 2-9 days only before rust appearance.

TABLE X—*con*

Year	Period of exposure	Dates of first spore shower. Number of spores in brackets	Dates of spore shower, if any, 4 to 2 weeks before rust appearance. Number of spores in brackets	Date of rust appearance, as reported from the station	Date of observation, if any, regarding incidence of rust
			15. Gorakhpur		
1930-31	December 1—January 25	December 1—17 (1)	December 1—17 (1)	December 31	
1931-32	December 14—March 4 ...	February 16—23 (2)	No spores	January 1st—2nd week	
1932-33	September 27—February 7	No spores	No spores	No information ...	February 28 (60 per cent)
1933-34	October 15—January 18 ...	October 25—28 (1)	November 25—28 (2) December 30—January 4(5)	February 1st and 2nd week‡	December 14 (traces)
1934-35	October 15—March 7 ...	December 10—13 (1)	No spores	December 31 ...	December 31 (40-50 per cent)
1935-36	October 15—March 21 ...	October 15—18 (1)	November 29—December 2 (2)	December 16	December 16 (traces)
1936-37	November 3—January 22	December 5—8 (1)	December 5—8 (1)	No information ...	January 5—6 (0-10 per cent)
1937-38	November 15—March 15	December 6—9 (1)	December 13—16 (1)	January 10	January 7 (0-3 per cent)
		16.	**Allahabad (Naini farm)**		
1929-30	December 16—March 3 ...	December 26—29 (1)	No spores	No information ...	February 4 (Common)
1936-37	December 3—March 6 ...	December 27—31 (1)	December 27—31 (1)	January 14	February 20 (30-90 per cent)
1937-38	November 16—March 16	December 25—29 (1)	January 10—14 (1)	January 30	March 10 (50-100 per cent)

TABLE X :ontd

Year	Period of exposure	Dates of first spore shower. Number of spores in brackets	Dates of spore shower, if any, 4 to 2 weeks before rust appearance. Number of spores in brackets	Date of rust appearance, as reported from the station	Date of observation, if any, regarding incidence of rust
			17. Cawnpore		
1930-31	January 17—March 10 ...	January 17—21 (2)	January 21—24 (1)	February 2nd week	
1931-32	November 15—February 7	No spores	...	No information	
1932-33	December 1—March 2 ...	February 2—6 (3)	No spores	February 1st week*	
1933-34	October 15—January 14 February 2—March 1	November 12—15 (1)	January 10—13 (26)	February 10	March 10 (abundant)
1934-35	October 19—March 11 ...	November 16—19 (15)	December 28—31 (1)	No rust	February 19 (90-100 per cent)
1935-36	October 18—March 9 ...	November 25—29 (1)	...	No information	
1936-37	January 1—March 15 ...	January 1—4 (2)	January 1—4 (2)	No information ...	February 25 (60-100 per cent)
1937-38	January 13—March 18 ...	February 12—15 (2)	February 12—15 (2)	March 1st week ...	March 11 (100 per cent)
			18. Bareilly (Nawabganj farm)		
1932-33	September 15—March 14	January 17—21 (2)	January17—21 (2)	February 1st week	
1933-34	October 22—February 28	December 10—13 (1)	December 10—13 (1) December 20—24 (1) December 24—27 (8)	January 13	Janu ry 7 (30 per cent)

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TAB X- con

Year	Period of exposure	Dates of first spore shower. Number of spores in brackets	Dates of spore shower, if any, 4 to 2 weeks before rust appearance. Number of spores in brackets	Date of rust appearance, as reported from the station	Date of observation, if any, regarding incidence of rust
		18. Bareilly (Nawabganj farm)—*Contd.*			
1934-35	October 15—March 12 ...	December 28—31 (6)	December 28—31 (6)	February 5	January 19 (traces)
1935-36	October 15—March 9 ...	December 7—9 (1)	January 21—24 (4)	February 8	
1936-37	November 15—March 20	January 6—9 (13)	No spores	No information ...	December 23 (0-20 per cent)
1937-38	November 15—March 15	December 14—17 (2)	...	No information	
		19. Shahjahanpur			
1932-33	September 15—February 21	February 18—21 (1)	...	No rust	
1933-34	October 15—February 4 ...	December 13—17 (2)	December 13—17 (2) Januar 3—7 (47)	February 1st week ...	February 1—2 (60 per cent)
1934-35	October 15—March 9 ...	January 22—25 (17)	January 22—25 (17)	February 11	
1935-36	October 15—March 22 ...	January 10—14 (2)	January 21—25 (1)	No information ...	February 7 (1-10 per cent)
1936-37	November 1—April 7 ...	December 22—26 (8)	January 2—5 (1)	January 4th week	
1937-38	November 15—March 21	No spores	No spores	February 14	
		20. Almora			
1932-33	October 26—March 2 ...	January 5—8 (1)	No spores	March 18	

TABLE X- :ontd.

Year	Period of exposure	Dates of first spore shower. Number of spores in brackets	Dates of spore shower, if any, 4 to 2 weeks before rust appearance. Number of spores in brackets	Date of rust appearance, as reported from the station	Date of observation, if any, regarding incidence of rust
			21. Tarikhet		
1933-34	October 20—March 15 ...	October 23—26 (1)	February 21—24 (15)	March 25	March 25—26 (10-20 per cent)
1934-35	October 15—March 26 ...	February 9—12 (2)	March 17—20 (6)	April 10	
1935-36	October 15—March 13 ...	November 24—27 (2)	January 2—5 (2)	January 24	
1936-37	January 25—April 18 ...	February 2—5 (1)	...	No information	
1937-38	November 15—March 18	No spores	...	No information	
			22.° Jhansi (Bharari farm) †		
1933-34	February 18—March 18 ...	February 18—21 (17)		No rust	March 5 (50-60 per cent)
1934-35	October 15—March 23 ...	January 15—17 (1)	February 12—15 (10)	February 28	
1935-36	November 8—March 30 ...	February 7—10 (1)	...	No information ...	
1936-37	November 11—February 8	December 28—January 1(1)	January 22—25 (2)	No rust	February 21 (0-10 per cent)
1937-38	November 15—March 21	January 18—20 (3)	January 21—24 (3)	February 20	
			23. Benares		
1933-34	October 22—February 14	November 15—19 (1)	No spores	February 20	January 16 (traces)
1934-35	October 15—March 15 ...	January 6—10 (1)	No spores	January 27	January 12 (traces)
1935-36	October 20—March 20 ...	December 28—31 (1)	December 28—31 (1)	January 19	
1936-37	November 1—March 17 ...	December 29—January 2(1)	December 29—January 2(1)	No information ...	February 18—19 (30-100 per cent)
1937-38	November 20—March 26...	No spores	No spores	No rust	January 31 (0-20 per cent)

Slides ore

TABLE X

Year	Period of exposure	Dates of first spore shower. Number of spores in brackets	Dates of spore shower, if any, 4 to 2 weeks before rust appearance. Number of spores in brackets	Date of rust appearance, as reported from the station	Date of observation, if any, regarding incidence of rust
			24. Fyzabad		
1934-35	November 15—March 13	December 5—8 (2)	December 29—January 1 (1)	Middle of January ...	March 6 (In teleuto stage)
1935-36	October 15—January 29 ...	January 8—11 (3)	January 8—11 (3)	February 2 ...	February 17 (40-60 per cent)
1936-37	November 1—February 25	November 28—December 1 (2)	December 7—10 (2)	December 4th week ...	February 21 (50-100 per cent)
1937-38	November 21—March 17	November 21—25 (1)	...	No information	
			25. Dehradun		
1935-36	October 15—March 20 ...	December 6—9 (1)	February 20—25 (1)	No information ...	March 18 (traces)
1936-37	November 2—March 16 ...	February 1—4 (2)	Februrary 1—4 (2)	February 23 ...	February 23 (0-65 per cent)
1937-38	November 15—March 18	February 8—11 (2)	March 12—15 (1)	March 31	
			BIHAR		
			26. Pusa		
1931-32	November 15—March 2 ...	December 24—27 (1)	No spores	December 26	
1932-33	September 15—March 19	December 1—5 (2)	December 1—5 (2)	December 29	
1933-34	October 16—February 8 ...	November 16—20 (3)	November 27—30 (4)	December 20 ...	December 20 (traces)

TABLE X· *'on*

Year	Period of exposure	Dates of first spore shower. Number of spores in brackets	Dates of spore shower, if any, 4 to 2 weeks before rust appearance. Number of spores in brackets	Date of rust appearance, as reported from the station	Date of observation, if any, regarding incidence of rust
			26. Pusa—*contd.*		
1934-35	October 15—March 11 ...	November 5—8 (1)	November 5—8 (1); November 8—12 (1); November 12—15	December 9	
1935-36	October 15—March 20 ...	November 26—29 (1)	December 6—10 (1)	December 23	January 9 (traces)
1936-37	November 20—April 30 ...	November 24—27 (1)	December 11—15 (1)	January 5	January 7—9 (0-5 per cent)
1937-38	November 15—March 21	January 13—16 (2)	No spores ...	January 9	January 9—10 (traces)
			27. Patna		
1932-33	September 15—February 21	January 9—13 (1)	January 9—13 (1)	No information ...	January 4th week (traces)
1933-34	October 28—February 15	December 11—14 (1)	December 11—14 (1); December 26—30 (1)	January 15	January 24—25 (70 per cent)
1934-35	October 15—February 27	December 10—14 (1)	No spores	January 4th week ...	February 22 (70-100 per cent)
1935-36	October 15—March 16 ...	December 22—26 (1)	December 22—26 (1)	February 5	January 8 (traces)
1936-37	November 27—April 9 ...	December 28—31 (1)	January 9—12 (1)	No information ...	February 2—4 (traces 20 per cent)
1937-38	December 1—March 20 ...	January 9—12 (1)	January 15—18 (2); January 24—27 (1)	February 9	March 6—7 (90-100 per cent)

Year	Period of exposure	Dates of first spore shower. Number of spores in brackets	Dates of spore shower, if any, 4 to 2 weeks before rust appearance. Number of spores in brackets	Date of rust appearance, as reported from the station	Date of observation, if any, regarding incidence of rust
			28. Sabour		
1932-33	September 15—February 19	January 8—11 (2)	January 26—29 (4)	March 2nd week* ...	March 13 (100 per cent)
1933-34	November 14—March 8 ...	December 21—24 (1)	December 21—24 (1) December 31—January 4(10)	January 18	January 23 (60 per cent)
1934-35	October 15—March 15 ...	January 21—24 (19)	February 11—14 (3)	February 28	
1935-36	October 16—March 16 ...	January 3—7 (1)	No spores	No information ...	January 1 (traces)
1936-37	November 26—April 19 ...	January 10—14 (6)	No spores	Early in January ...	January 27—28 (5-90 per cent)
1937-38	November 21—March 24	January 23—27 (1)	January 23—27 (1)	February end of 2nd week	March 5 (10-100 per cent)
			BENGAL		
			29. Mymensingh		
1932-33	September 15—December 22	No spores	...	No crop	
1933-34	March 1—14 ...	No spores	...	No rust	
1934-35	October 15—March 12 ...	February 28—March 3 (1)	...	No rust	
1935-36	October 15—December 31	No spores	...	No rust	

* R[illegible] ha[illegible] [illegible]ppeared about

TAB X—co

Year	Period of exposure	Dates of first spore shower Number of spores in brackets	Dates of spore shower, if any, 4 to 2 weeks before rust appearance. Number of spores in brackets	Date of rust appearance, as reported from the station	Date of observation, if any, regarding incidence of rust
			ASSAM		
			30. Shillong		
1932-33	September 15—January 26	No spores	...	No crop	
			RAJPUTANA		
			31. Ajmer		
1931-32	November 14—March 12	November 18—21 (1)	No spores	February 26	
1932-33	December 15—March 5 ...	No spores	...	No information	
1933-34	October 15—February 27	November 20—23 (1)	No spores	March 9	
1934-35	October 15—February 26	February 6—9 (1)	February 6—9 (1)	March 7	March 11 (traces)
1935-36	October 15—February 1 ...	January 9—14 (1)	† ...	March 13	
1936-37	November 4—Februrary 29	January 9—12 (1)	...	No rust	
1937-38	November 10—Ja uary 11	No spores	...	No rust	
			32. Sriganganagar (Bikaner State)		
1934-35	October 30—March 18 ...	February 18—23 (1)	No spores ...	March 1st week	
1935-36	October 31—March 31 ...	January 3—7 (1)	...	No rust	
1936-37	November 17—March 18	No sopres	...	No rust	
1937-38	December 14—April 5 ...	No spores	...	No rust	

No

TABLE X—*contd.*

Year	Period of exposure	Dates of first spore shower. Number of spores in brackets	Dates of spore shower, if any, 4 to 2 weeks before rust appearance. Number of spores in brackets	Date of rust appearance, as reported from the station	Date of observation, if any, regarding incidence of rust
			CENTRAL INDIA		
			33. Indore		
1932-33	September 15—January 19	December 22—27 (1)	...	No rust	
1933-34	March 2—15 ...	No spores	...	No rust	
1934-35	October 15—March 14 ...	No spores	...	No information	
1935-36	October 15—March 19 ...	November 7—11 (2)	...	No rust	
1936-37	November 2—March 18 ...	No spores	...	No rust	
1937-38	November 16—March 15	No spores	...	No rust	
			CENTRAL PROVINCES		
			34. Jubbulpore (Adhartal farm)		
1931-32	December 8—March 4 ...	No spores	No spores	March 3	March 3 (1-30 per cent)
1932-33	September 16—March 2	January 25—28 (1)	...	No information	
1933-34	October 15—January 27 ...	October 25—28 (1)	January 6—10 (3)	January 30	March 3 (5 per cent)
1934-35	October 15—March 29 ...	January 21—24 (3)	January 31—February 3 (5)	February 17 ...	February 25 (20-30 per cent)
1935-36	October 15—March 20 ...	December 12—16 (1)	...	No information	
1936-37	November 7—February 10	No spores	No spores	January 19	
1937-38	November 15—January 19	No spores	...	No rust	

TABLE X—contd

Year	Period of exposure	Dates of first spore shower. Number of spores in brackets	Dates of spore shower, if any, 4 to 2 weeks before rust appearance. Number of spores in brackets	Date of rust appearance, as reported from the station	Date of observation, if any, regarding incidence of rust
			35. Nagpur		
1929-30	January 2—March 19 ...	No spores	...	No rust	
1930-31	January 3—March 20 ...	February 11—14 (7)	...	No information	
1931-32	November 20—March 7 ...	January 22—25 (8)	February 20—23 (6) February 23—24 (70)	No information ...	March 6 (1 per cent)
1933-34	February 28—March 15 ...	March 3—7 (1)	...	No rust	
1934-35	October 18—March 12 ...	No spores	...	No information	
1935-36	November 20—March 11	No spores	...	No rust	
1936-37	November 2—March 18 ...	No spores	...	No information	
1937-38	November 13—March 12	No spores	...	No rust	
			36. Khandwa		
1931-32	December 24—February 25	No spores	...	No rust ...	
1932-33	October 18—March 16 ...	February 20—23 (1)	...	No rust	
1933-34	October 20—January 26 ...	December 22—25 (1)	January 6—9 (3) January 9—13 (36)	January 24	March 4 (10 per cent)

TABLE X—*contd.*

Year	Period of exposure	Dates of first spore shower. Number of spores in brackets	Dates of spore shower, if any, 4 to 2 weeks before rust appearance. Number of spores in brackets	Date of rust appearance, as reported from the station	Date of observation, if any, regarding incidence of rust
			37. Pachmarhi		
1932-33	December 12—February 12	No spores	...	No rust	
1933-34	March 4—17 ...	March 11—14 (1)	...	No rust	
1934-35	October 19—March 19 ...	No spores	...	No rust	
1935-36	October 15—March 21 ...	No spores	...	No rust	
1936-37	November 1—April 4 ...	No spores	...	No rust	
1937-38	November 15—March 21	No spores	...	No rust	
			38. Powarkhera near Hoshangabad		
1934-35	November 23 —March 14	December 30—January 5(1)	...	No information	
1935-36	October 16—March 14 ...	January 8—11 (4)	...	No information	
1936-37	November 8—March 15 ...	January 10—14 (1)	January 10—14 (1)	January 28	
1937-38	November 15—March 21	No spores ...	...	No rust	
			39. Saugor		
1936-37	December 22—February 25	January 3—7 (2)	...	No information	
1937-38	November 15—March 20	No spores	...	No rust	

TABLE X—*contd.*

Year	Period of exposure	Dates of first spore shower. Number of spores in brackets	Dates of spore shower, if any, 4 to 2 weeks before rust appearance. Number of spores in brackets	Date of rust appearance, as reported from the station	Date of observation, if any, regarding incidence of rust
			40. Raipur (Labhandi farm)		
1936-37	November 10—April 2 ...	No spores	...	No rust	
1937-38	November 15—March 17	No spores	...	No information	
			BOMBAY-DECCAN		
			41. Poona (College farm)		
1931-32	October 15—January 7 ...	No spores	...	No information	
1932-33	August 5—December 25	No spores	...	No information	
1933-34	September 21—December 7	October 26—30 (1)	...	No information	
1934-35	October 22—March 7 ...	December 31—January 3 (1)	...	No information	
1935-36	October 14—February 17	December 2—5 (1)	...	No information	
1936-37	October 15—February 18	No spores ...	...	No rust	
1937-38	October 1—February 4 ...	November 19—23 (1)	...	No information	

TAB ontd

Year	Period of exposure	Dates of first spore shower. Number of spores in brackets	Dates of spore shower, if any, 4 to 2 weeks before rust appearance. Number of spores in brackets	Date of rust sppearance, as reported from the station	Date of observation, if any, regarding incidence of rust
		42. Poona (Observatory tower 120 feet above ground)			
1933-34	September 15—December 3	September 29—October 2(1)	...	No crop	
1934-35	November 10—January 23	November 21—24 (1)	...	No crop	
1935-36	October 15—December 21	November 2—6 (2)	...	No crop	
1936-37	October 29—December 14	No spores	...	No crop	
1937-38	November 15—January 17	December 27—31 (1)	...	No crop	
			43. Niphad		
1931-32	October 22—January 17 ...	No spores	...	No information	
1932-33	August 9—December 12	August 30—September 2(2)	...	No information	
1933-34	September 15—January 15	December 5—8 (1)	...	No information	
1934-35	October 2—March 5 ...	January 1—4 (1)	...	No information	
1935-36	October 15—February 18 ...	No spores	...	No information	
1936-37	October 15—February 19	No spores	...	No rust	
1937-38	October 1—January 28 ...	No spores	...	No information	

TABLE X· 'd

Year	Period of exposure	Dates of first spore shower. Number of spores in brackets	Dates of spore shower, if any, 4 to 2 weeks before rust appearance. Number of spores in brackets	Date of rust appearance, as reported from the station	Dat any,
			44. Dharwar		
1931-32	October 22—January 17 ...	No spores	...	No information	
1932-33	August 12—December 16	No spores	...	No information	
1933-34	September 15—January 18	January 1—5 (4)	...	No information	
1934-35	September 28—February 15	No spores	...	No information	
1935-36	October 15—February 16	December 8—12 (1)	December 21—25 (1)	January 15	
1936-37	September 20—February 20	No spores	...	No rust	
1937-38	October 5—February 8 ...	No spores	...	No information	
			45. Arbhavi (Belgaum)		
1932-33	August 8—December 15	No spores	...	No information	
1933-34	September 15—December 31	November 13—17 (1)	...	No information	
1934-35	October 1—February 11 ...	February 1—4 (14)	...	No rust	
1935	October 15—February 18	Decembe[illegible]		No info[illegible]ion	
936	September 20—February 15	No spores		No rust	
	October 1—February 22 ...	No spores		No rust	

TABLE X—*c*

Year	Period of exposure	Dates of first spore shower. Number of spores in brackets	Dates of spore shower, if any, 4 to 2 weeks before rust appearance. Number of spores in brackets	Date of rust appearance, as reported from the station	Date of observation, if any, regarding incidence of rust
			46. Dohad		
1931-32	October 24—January 19 ...	December 23—26 (1)	...	No information	
1932-33	September 3—January 7	No spores	...	No information	
1933-34	September 27—January 31	No spores	...	No information	
1934-35	October 1—March 7 ...	No spores	No spores	February 25	
1935-36	October 20—February 23	December 4—8 (1)	...	No information	
1936-37	October 15—February 18	No spores	...	No rust	
1937-38	October 1—March 12 ...	No spores	...	No rust	
			47. Wagra (Gujrat)		
1932-33	July 20—January 25 ...	No spores	...	No rust	
1933-34	February 10—24 ...	No spores	...	No information	
			48. Baroda		
1932-33	September 21—November 23	No spores	...	No information	
1933-34	September 15—February 19	November 17—20 (1)	...	No information	
1934-35	September 15—February 12	February 5—9 (1)	No spores February 5—9 * (1)	February 18 ...	February 28 (traces 10 per cent)

* Spore shower 13 to 9 days only before rust appearance.

TABLE X- ontd

Year	Period of exposure	Dates of first spore shower. Number of spores in brackets	Dates of spore shower, if any, 4 to 2 weeks before rust appearance. Number of spores in brackets	Date of rust appearance, as reported from the station	Date of observation, if any, regarding incidence of rust
			48. Baroda—*contd*.		
1935-36	October 15—March 13 ...	December 17—20 (1)	January 21—24 (2)	February 12	
1936-37	October 15—March 23 ...	No spores	No spores	January 4th week	
1937-38	October 1—February 4 ...	No spores	...	No information	
			49 Broach		
1934-35	October 1—February 28 ...	No spores	...	No information	
1935-36	October 21—February 18	January 6—9 (1)	No spores	February 16	
1936-37	October 21—February 27	No spores	...	No information	
1937-38	October 1—February 4 ...	No spores	...	No information	
			50. Jagudan (Mehsana)		
1932-33	October 7—December 8 ...	October 7—10 (1)	...	No information	
1933-34	September 15—January 28	No spores	...	No information	
1934-35	September 19—March 3 ...	February 12—15 (1)	February 12—15 (1) February 15—18 (1)	No information ...	March 4 (10 per cent)
1935-36	October 15—February 17	December 31—January 3 (15)	January 14—17 (4)	February 7	
1936-37	October 15—February 18	No spores	...	No rust	
1937-38	October 1—March 31 ...	No spores	...	No information	

TABLE X-

Year	Period of exposure	Dates of first spore shower. Number of spores in brackets	Dates of spore shower, if any, 4 to 2 weeks before rust appearance. Number of spores in brackets	Date of rust appearance, as reported from the station	Date of observation, if any, regarding incidence of rust
			51. Amreli		
1932-33	October 10—January 12 ...	No spores	...	No information	
1933-34	January 2—February 2 ...	January 9—12 (2)	...	No rust	
1934-35	September 15—February 22	No spores	No spores ...	February 9 ...	March 2 (40 per cent)
1935-36	October 16—February 16	December 23—27 (1)	...	No information	
1936-37	October 15—February 26	No spores	...	No information	
1937-38	October 2—March 14 ...	No spores	...	No rust ...	
			HYDERABAD-DECCAN		
			52. Parbhani		
1932-33	August 4—November 7 ...	No spores	...	No information	
1933-34	September 18—January 31	September 28—October 1 (1)	...	No information	
1934-35	September 15—March 10	No spores	No spores ...	No information ...	January 21 (1—2 per cent)
1935-36	October 15—March 3 ...	November 27—December 1 (2)	...	No information	
1936-37	December 25—March 27	No spores	...	No rust	
1937-38	October 7—February 10 ...	No spores	...	No rust	

Year	Period of exposure	Dates of first spore shower. Number of spores in brackets	Dates of spore shower, if any, 4 to 2 weeks before rust appearance. Number of spores in brackets	Date of rust appearance, as reported from the station	Date of observation, if any, regarding incidence of rust
			53. Himayatsagar (Hyderabad)		
1932-33	July 22—January 9 ...	No spores	No spores ...	January 1st week	
1933-34	September 21—January 9	November 18—23 (1)	November 30—December 7 (1) December 22—27 (1)	Middle of January ...	January 20—21 (1-100 per cent)
1934-35	September 19—February 11	December 22—25 (1)	...	No information	
1935-36	October 15—February 15	October 15—18 (1)	...	No information	
1936-37	October 16—February 15	November 17—21 (3)	...	No rust	
1937-38	October 19—January 27 ...	No spores	...	No information	
			54. Raichur		
1932-33	July 16—November 16 ...	No spores	...	No crop	
			MADRAS		
			55. Bellary (Hagari farm)		
1932-33	July 15—November 17 ...	October 28—31 (2)	...	No rust	
1933-34	September 15—January 18	December 11—15 (2)	...	No information	
1934-35	August 17—February 22 ...	February 18—22 (1)	...	No rust	
1935-36	June 15—February 21 ...	October 18—22 (1)	...	No information	
1936-37	August 12—March 31 ...	No spores	...	No rust	
1937-38	August 20—March 1 ...	No spores	...	No rust	

TABLE X—*contd*

Year	Period of exposure	Dates of first spore shower. Number of spores in brackets	Dates of spore shower, if any, 4 to 2 weeks before rust appearance. Number of spores in brackets	Date of rust appearance, as reported from the station	Date of observation, if any, regarding incidence of rust
			56. Coimbatore		
1932-33	July 15—December 19 ...	No spores ...	...	No information	
1933-34	September 18—February 1	October 5—9 (1)	No spores ...	December 26 ...	December 27—28 (10-40 per cent)
1934-35	May 18—February 18 ...	July 16—19 (3)	December 27—31 (2)	January 21 ...	
1935-36	October 15—February 18	November 8—12 (1)	November 15—19 (2) November 22—26 (1)	December 9	
1936-37	August 20—February 15 ...	August 20—24 (1)	October 22—26 (2)	November 16	
1937-38	August 17—January 28 ...	No spores	No spores	September 28	
			57. Guntur		
1932-33	July 15—November 15 ...	No spores	...	No rust	
1933-34	September 15—January 19	September 29—October 3(1)	...	No information	
1934-35	July 17—February 19 ...	September 14—18 (2)	...	No information	
1935-36	June 14—February 25 ...	October 11—15 (1)	...	No rust	
1936-37	August 15—March 9 ...	August 15—18 (1)	...	No information	
1937-38	September 2—January 17	No spores	...	No rust	

TABLE X *contd*

Year	Period of exposure	Dates of first spore shower. Number of spores in brackets	Dates of spore shower, if any, 4 to 2 weeks before rust appearance. Number of spores in brackets	Date of rust appearance, as reported from the station	Date of observation, if any, regarding incidence of rust
			58. Koilpatti		
1932-33	July 25—December 30 ...	No spores	...	No crop	
			59. Anthiyur		
1936-37	August 22—January 25 ...	August 22—26 (1)	June 21—25 (1)	February 13	
			60. Udumalpet		
1937-38	September 7—February 18	January 7—11 (1)	*	No information	March 9 (0.5 per cent)
			MYSORE STATE		
			61. Hebbal near Bangalore		
1932-33	October 2—February 15 ...	December 8—12 (4)	January 17—20 (1)	February 4	
1933-34	September 15—December27	October 10—14 (1)	...	No rust	
1934-35	June 16—January 18 ...	August 15—19 (3)	...	No rust	
1935-36	September 17—January 2	No spores	...	No rus	
1936-37	September 25—March 20	October 1—6 (1)	...	No rust	
1937-38	September 27—March 4 ...	No spores	...	No information	

* S[illegible]ed after February 18, 193[illegible]

TABLE X—*contd.*

Year	Period of exposure	Dates of first spore shower. Number of spores in brackets	Dates of spore shower, if any, 4 to 2 weeks before rust appearance. Number of spores in brackets	Date of rust appearance, as reported from the station	Date of observation, if any, regarding incidence of rust
			62. Mandya (Mysore)		
1932-33	October 22—January 24 ...	December 31—January 3(1)	December 31—January 3(1)	January 15	
1933-34	September 19—February 4	November 27—30 (1)	...	No rust	
1934-35	May 15—February 17 ...	August 2—6 (56)	...	No rust	
1935-36	June 17—November 21 ...	September 26—29 (1)	September 26—30 (1)	October 16 †	
1936-37	August 15—March 29 ...	November 17—20 (2)	February 25—March 1 (1)	March 15	
1937-38	August 20—February 28 ...	October 4—7 ...	...	No information	
			63. Hiriyur (Chitaldroog)		
1932-33	October 14 —January 17 ...	No spores	...	No information	
1933-34	September 21—January 11	October 31—November 3(1)	October 31—November 3(1)	No information ...	December 15 (over 60 per cent)‡
1934-35	May 15—July 16 February 5—19	February 8—12 (7)	§ ...	No rust	November 30 (5 per cent)*
1935-36	June 20—February 25 ...	September 23—26 (1)	...	No information	
1936-37	August 15—January 23 ...	No spores	...	No information	
1937-38	August 20—January 26 ...	No spores ...	...	No information	

† In miniature plots sown at the request of the writer in August.

‡ On crop sown in Siddavanahalli nearly 20 miles from Hiriyur.

§ No slides were exposed from July 16, 1934 to February 5, 1935.

* On crop sown in August at Chitaldroog nearly 30 miles from Hiriyur.

Note.—Slides were exposed in aeroscopes at 62 stations. At Poona, two aeroscopes (Nos. 41 and 42) were exposed, hence the total number comes to 63.

TABLE XI

Summary of data given in Table X

Serial number	Province and name of station	Number of years during which slides were exposed	Number of years when spore showers took place	Number of years when spores were caught 4 to 2 weeks before rust appearance	Number of years when no spores could be detected 4 to 2 weeks before rust appearance	Number of years when no rust appeared or no information was received regarding rust appearance
	PUNJAB					
1	**Lyallpur**	9	7	7	1	1
2	**Gurdaspur** ...	7	5	3*	...	3
3	**Rupar**	6	4	...	...	6
4	**Hoshiarpur** ...	7	6	1	5	1
5	**Rawalpindi** ...	6	6	1	2	3
6	**Simla**	6	6	4	2	None
7	**Khanewal**	5	3	3	...	2
8	**Karnal**	5	4	2	3	None
	BALUCHISTAN					
9	**Quetta**	5	2	...	1	4
	N. W. F. PROVINCE					
10	**Peshawar**	3	None	...	1	2
	SIND					
11	**Karachi**	1	No spores	...	...	1
12	**Sakrand**	6	3	3	1	2
	DELHI					
13	**Delhi**	2	2	1	1	Neither
	UNITED PROVINCES					
14	**Agra**	9	8	4	5	None
15	**Gorakhpur** ...	8	7	5	3	None
16	**Allahabad** ...	3	3	2	1	None

* No slides were exposed during that period in one of the years.

TABLE XI—*contd.*

Serial number	Province and name of station	Number of years during which slides were exposed	Number of years when spore showers took place	Number of years when spores were caught 4 to 2 weeks before rust appearance	Number of years when no spores could be detected 4 to 2 weeks before rust appearance	Number of years when no rust appeared or no information was received regarding rust appearance
17	**Cawnpore** ...	8	7	5	1	2
18	**Bareilly**	6	6	4	1	1
19	**Shahjahanpur** ...	6	5	4	1	1
20	**Almora**	1	1	...	1	...
21	**Tarikhet**	5	4	3	...	2
22	**Jhansi**	5	5	3*	...	1
23	**Benares**	5	4	2	3	None
24	**Fyzabad**	4	4	3	...	1
25	**Dehradun**	3	3	3	None	None
	BIHAR					
26	**Pusa**	7	7	5	2	None
27	**Patna**	6	6	5	1	None
28	**Sabour**	6	6	4	2	None
	BENGAL					
29	**Mymensingh** ...	4	1	...	...	4
	ASSAM					
30	**Shillong**	1	No spores	...	...	1†
	RAJPUTANA					
31	**Ajmer**	7	5	1*	2	3
32	**Sriganganagar** ...	4	2	...	1	3
	CENTRAL INDIA					
33	**Indore**	6	2	...	...	6

† There was no crop at Shillong
* No slides were exposed during that period in one of the years

TABLE XI—*contd.*

Serial number	Province and name of station	Number of years during which slides were exposed	Number of years when spore showers took place	Number of years when spores were caught 4 to 2 weeks before rust appearance	Number of years when no spores could be detected 4 to 2 weeks before rust appearance	Number of years when no rust appeared or no information was received regarding rust appearance
	CENTRAL PROVINCES					
34	**Jubbulpore** ...	7	4	2	2	3
35	**Nagpur**	8	3	1	...	7
36	**Khandwa**	3	2	1	...	2
37	**Pachmarhi** ...	6	1	...	...	6
38	**Powarkhera (Hoshangabad)** ...	4	3	1	...	3
39	**Saugor**	2	1	...	...	2
40	**Raipur**	2	Neither	...	...	2
	BOMBAY-DECCAN					
41	**Poona (College farm)**	7	4	...	...	7
42	**Poona (Observatory tower 120 feet above ground)**	5	4	...	...	5*
43	**Niphad**	7	3	...	...	7
44	**Dharwar**	7	2	1	...	6
45	**Arbhavi**	6	3	...	...	6
46	**Dohad**	7	2	...	1	6
47	**Wagra**	2	Neither	...	...	2
48	**Baroda**	6	3	1	2	3
49	**Broach**	4	1	...	1	3
50	**Jagudan**	6	3	2	...	4
51	**Amreli**	6	2	...	1	5
	HYDERABAD-DECCAN					
52	**Parbhani**	6	2	...	1	5
53	**Himayatsagar** ...	6	4	1	1	4
54	**Raichur**	1	No spores	...	...	1†

* No crop is sown at Poona (Observatory)
† There was no crop that year

TABLE XI—*contd.*

Serial number	Province and name of station	Number of years during which slides were exposed	Number of years when spore showers took place	Number of years when spores were caught 4 to 2 weeks before rust appearance	Number of years when no spores could be detected 4 to 2 weeks before rust appearance	Number of years when no rust appeared or no information was receivd regarding reust appearance
	MADRAS					
55	**Bellary (Hagari)** ...	6	4	...	...	6
56	**Coimbatore** ...	6	4	3	..	1
57	**Guntur**	6	4	...	...	6
58	**Koilpatti**	1	No spores	...	...	1‡
59	**Anthiyur**	1	1	1	...	...
60	**Udumalpet** ...	1	1	*	...	...
	MYSORE STATE					
61	**Hebbal (Bangalore)** ...	6	4	1	...	5
62	**Mandya (Mysore)** ...	6	6	3	...	3
63†	**Hiriyur (Chitaldroog)**	6	3	1*	...	

‡ There was no crop that year.

* No slides were exposed during that period in one of the years.

† The total number of stations was 62. At Poona, two aeroscopes were exposed.

TABLE XII

Study of slid... up on big balloons (with spore catch...rs), small balloons and kites a... gra... ...on to the appearance of brown rust *during 1929 to 1938*

Year	Period of kite and balloon flights	Range of height in feet reached by different kites and balloons during the year	Dates on which (*a*) Spores were first caught and (*b*) Spores caught 4 to 2 weeks before rust appearance Number of spores. in brackets	Height reached by kites or balloons on dates given in previous column and direction of winds	Duration of exposure of slides	Date of rust appearance
1929-30*	February 11 (2 balloons only) ...	1,500 ft. and 3,000 ft. ...	(*a*) February 11 (2)†	1,500 ft.; N.N.W. ...	Nearly 5 min. ...	January 29
1930-31*	December 16—February 20 (4 balloons only)	1,640 ft. to 4,756 ft. ...	No spores	...	Nearly 5 min.	January 18
1931-32*	December 3 (1 balloon only) ...	1,673 ft.	No spores	...	2½ min.	February 2nd week
1931-32	December 3—March 14 ...	400 ft. to 4,372 ft. ...	(*a*) January 11 (1)K (*b*) January 21 (1)B	1,200 ft.; N.W. ... 3,052 ft.; N.W. ...	1¼ hr. ... 50 min. ...	February 2nd week
1932-33	December 12—March 10	654 ft. to 4,088 ft. ...	(*a*) January 6 (1)K (*b*) February 6 (1)K	1,310 ft.; N. & N.W. ... 1,143 ft.; W. & N.W. ...	2¼ hr. ... 2¾ hr. ...	February 19
1933-34	December 15—January 31	450 ft. to 3,300 ft. ...	(*a*) December 20 (1)B (*b*) January 2 (1)B	3,300 ft.; Calm ... 1,650 ft.; S. & S.W. ...	40 min. ... 1¾ hr.	February 1

* During these years, slides, were sent up for preliminary trials on large balloons to which 'spore-catchers' were attached. The 'spore-catcher' is described in Appendix A.

† These spores were caught after the rust had appeared at Agra.

B refers to a drum attached to a pair of small balloons and K a kite to which a small balloon was occasionally attached.

TABLE X 'd

Year	Period of kite and balloon flights	Range of height in feet reached by different kites and balloons during the year	Dates on which (*a*) Spores were first caught and (*b*) Spores caught 4 to 2 weeks before rust appearance Number of spores in brackets	Height reached by kites or balloons on dates given in previous column and direction of winds	Duration of exposure of slides	Date of rust appearance
1934-35	November 20—March 14	825 ft. to 3,290 ft. ...	(*a*) January 10 (1)K (*b*) January 18 (1)K	1,000 ft.; W. ... 1,300 ft.; N.W. ...	1½ hr. ... 2 hr.	February 2
1935-36	November 15—February 29	1,000 ft. to 3,280 ft. ...	(*a*) December 18 (2)K (*b*) January 20 (1)B	1,640 ft.; N.W. ... 3,280 ft.; Calm ...	1½ hr. ... 1½ hr.	February 5
1936-37	November 17—March 1 ...	1,000 ft. to 2,300 ft. ...	(*a*) No spores ... (*b*) No spores	...	‡	February 15
1937-38	November 15—February 22	800 ft. to 2,000 ft. ...	(*a*) No spores ... (*b*) No spores	...	‡	February 3

Slides were exposed for 1 to

TABLE XIII

Su ry of data giv in ap Nos. 55 to 89 conce ng h dis nation of **brown rus**

Map number	Year	Height of the wind in feet above sea level	Date of wind trajectory	Dates of spore shower soon after the wind. Dates of subsequent showers, if any, 14 to 10 days or so before rust appearance within brackets	Date of rust appearance, as reported from the station. Incidence* within brackets	Area or stations where rust had appeared at least 15 days earlier. Dates of rust appearance or incidence* within brackets
				PUNJAB		
				Lyallpur (605 feet above sea level)		
55	1936-37 ...	1,640	February 25 ...	February 25—March 1 and March 1—4 (March 8—11) ...	March 20 ...	Gurdaspur (December 4) Hoshiarpur (January 15)
56	1935-36 ...	3,280	March 3 ...	March 3—6 and 6—10)March 10—14) ...	March 27 ...	Peshawar (January 2nd week)
	1935-36 ...	4,920	March 3 ...	March 6—10 ... (March 10—14) ...	March 27 ...	Peshawar (January 2nd week)
	1935-36 ...	6,560	March 3 ...	March 6—10 and 10—14 (March 10—14) ...	March 27 ...	Peshawar (January 2nd week)
				Hoshiarpur (702 feet above sea level)		
57	1936-37 ...	1,640	December 22 ...	... (January 5—8)	January 15 ...	Gurdaspur (December 4)
	1936-37 ...	3,280	December 22 ...	... (January 5—8)	January 15 ...	Gurdaspur (December 4)
	1936-37 ...	4,920	December 22 ...	... (January 5—8) ...	January 15 ...	Gurdaspur (December 4)
	1936-37 ...	6,560	December 22 ...	... (January 5—8) ...	January 15 ...	Gurdaspur (December 4)

* Observations made by members of the Rust Research Staff or occasionally the writer. Range of crop infection relates to different fields and on different varieties in that locality.

Note.—As stated under Methods of study, the date of rust appearance was put back by 3 to 4 weeks in such cases where a member of the Rust Research Staff found heavy infection (70 per cent or above) within a week or so of the reported date of first appearance of rust at the station concerned.

TAB X d

Map number	Year	Height of the wind in feet above sea level	Date of wind trajectory	Dates of spore shower soon after the wind. Dates of subsequent showers, if any, 14 to 10 days or so before rust appearance within brackets	Date of rust appearance, as reported from the station. Incidence within brackets	Area or stations where rust had appeared at least 15 days earlier. Dates of rust appearance or incidence within brackets
				Karnal (900 feet above sea level)		
58	1934-35 ...	1,640	February 4 ...	...	February 26 ...	Simla (January 18)
				SIND		
				Sakrand (120 feet above sea level)		
59	1936-37 ...	1,640	February 23 ...	...	March 20 ...	Central Nepal (December 6; 10 per cent) Shahjahanpur (January 4th week)
				DELHI		
				Delhi (714 feet above sea level)		
60	1937-38 ...	1,640	January 25 ...	...	February 15 ...	Pusa (January 9) and Gorakhpur (January 7—; 0-3 per cent)
				UNITED PROVINCES		
				Agra (554 feet above sea level)		
61	1933-34 ...	1,640	January 10 ...	January 10—14 ... (January 21—24)	February 1 ...	Gorakhpur (December 14; traces)
62	1936-37 ...	1,640	January 25 ...	... (February 3—6)	February15 ...	Bareilly (December 23; 0-20 per cent)
63	1933-34 ...	3,280	January 8 ...	January 10—14 ... ... (January 21—24)	February 1 ...	Conda (December 10; traces)
64	1936-37 ...	6,560	January 27 ...	... (February 3—6)	February 15 ...	Gurdaspur (December 4)

TAB: X: :ontd.

Map number	Year	Height of the wind in feet above sea level	Date of wind trajectory	Dates of spore shower soon after the wind. Dates of subsequent showers, if any, 14 to 10 days or so before rust appearance within brackets	Date of rust appearance, as reported from the station. Incidence within brackets	Area or stations where rust had appeared at least 15 days earlier. Dates of rust appearance or incidence within brackets
				Gorakhpur (257 feet above sea level)		
65	1936-37 ...	1,640	December 4 ...	December 5—8 ... ... ( )	No information ... (January 5—6; 0-10 per cent)	Central Nepal (December 6; 10 per cent)
	1936-37 ...	3,280	December 4 ...	December 5—8* ... ... ( )	No information ... (January 5—6; 0-10 per cent)	Central Nepal (December 6; 10 per cent)
	1936-37 ...	4,920	December 4 ...	December 5—8* ... ... ( )	No information ... (January 5—6; 0-10 per cent)	Central Nepal (December 6; 10 per cent)
66	1936-37 ...	6,560	December 3 ...	December 5—8* ... ... ( )	No information ... (January 5—6; 0-10 per cent)	Central Nepal (December 6; 10 per cent)
				BIHAR **Pusa (188 feet above sea level)**		
67	1936-37 ...	1,640	December 13 ...	*December 11—15** ... (December 22—25 and 25—29)	January 5 ...	Central Nepal (December 6; 10 per cent)
	1936-37 ...	3,280	December 13 ...	*December 11—15** ... (December 22—25 and 25—29)	January 5 ...	Central Nepal (December 6; 10 per cent)
68	1936-37 ...	4,920	December 20 ...	December 22—25 and 25—29 (December 22—25 and 25—29)	January 5 ...	Central Nepal (December 6; 10 per cent)
67	1936-37 ...	6,560	December 13 ...	††December 11—15** ... (December 22—25 and 25—29)	January 5 ...	Central Nepal (December 6; 10 per cent)

* The wind referred to in the previous column has been included in the list of those followed by spore showers in Table XIV but marked with a query.
** The spore shower might have occurred on December 11 or 12, due to some earlier wind
†† The wind referred to in the previous column has not been included in the list of those followed by spore showers in Table XIV because of its height.

TABLE XIII—*contd.*

Map number	Year	Height of the wind in feet above sea level	Date of wind trajectory	Dates of spore shower soon after the wind. Dates of subsequent showers, if any, 14 to 10 days or so before rust appearance within brackets	Date of rust appearance, as reported from the station. Incidence within brackets	Area or stations where rust had appeared at least 15 days earlier. Dates of rust appearance or incidence within brackets
				Sabour (122 feet above sea level)		
69	1934-35 ...	1,640	February 10 ...	February 11—14 ... (February 14—18) ...	February 28 ...	Western Nepal (December 7 ; traces) Bahraich (January 5 ; 10-30 per cent) Gonda (January 2 ; 20-40; per cent) Fyzabad (Middle of January) Gorakhpur (December 31 ; 40-50 per cent)
	1934-35 ...	3,280	February 10 ...	February 11—14 and 14—18 ... (February 14—18)	February 28 ...	Simla (January 18) Bareilly (January 19 ; traces) Fyzabad (Middle of January)
	1934-35 ...	4,920	February 10 ...	February 11—14 and 14—18 ... (February 14—18)	February 28 ...	Cawnpore (February 19 ; 90-100 per cent) Benares (January 12 ; traces)
	1934-35 ...	6,560	February 10 ...	February 14—18 ... (February 14—18) ...	February 28 ...	Western Nepal (December 7 ; traces) Bahraich (January 5 ; 10-30 per cent) Gonda (January 2 ; 20-40 per cent) Gorakhpur (December 31 ; 40-50 per cent) Pusa (December 9)
70	1936-37 ...	1,640	December 10 ...	...	Early in January ...	Central Nepal (December 6 ; 10 per cent)
	1936-37 ...	3,280	December 10 ...	...	Early in January ...	Central Nepal (December 6 ; 10 per cent)
	1936-37 ...	4,920	December 10 ...	...	Early in January ...	Central Nepal (December 6 ; 10 per cent)
71	1936-37 ...	6,560	December 11 ...	...	Early in January ...	Central Nepal (December 6 ; 10 per cent)

TABLE X *contd*

Map number	Year	Height of the wind in feet above sea level	Date of wind trajectory	Dates of spore shower soon after the wind. Dates of subsequent showers, if any, 14 to 10 days or so before rust appearance within brackets	Date of rust appearance, as reported from the station. Incidence within brackets	Area or stations where rust had appeared at least 15 days earlier. Dates of rust appearance or incidence within brackets
				Sabour (122 feet above sea level)—*contd.*		
72	1937-38 ...	1,640	January 26 ...	*January 23—27** ... ( )	February end of 2nd week.	Gauhati (February 7; traces—100 per cent) Dhubri (January 18—19; 0-25 per cent)
73	1937-38 ...	3,280	January 25 ...	*January 23—27‡ ... ... ( )	February end of 2nd week.	Dhubri (January 18—19; 0-25 per cent)
				BENGAL		
				Mymensingh (62 feet above sea level)		
74	1936-37 ...	1,640	December 22 ...	†	Did not appear ... (February 13; traces-75 per cent)	Central Nepal (December 6; 10 per cent)
75	1936-37 ...	3,280	December 23 ...	†	Did not appear (February 13; traces-75 per cent)	Central Nepal (December 6; 10 per cent)
76	1936-37 ...	4,920	December 16 ...	†	Did not appear (February 13; traces-75 per cent)	Central Nepal (December 6; 10 per cent)
77	1936-37 ...	6,560	December 17 ...	†	Did not appear (February 13; traces-75 per cent)	Central Nepal (December 6; 10 per cent)

* The wind referred to in the previous column has been included in the list of those followed by spore showers in Table XIV but marked with a query
** The spore shower might have occurred on January 23, 24 or 25, due to some earlier wind
‡ The spore shower might have occurred on January 23 or 24, due to some earlier wind
† No slides were exposed

TABL

Map number	Year	Height of the wind in feet above sea level	Date of wind trajectory	Dates of spore shower soon after the wind. Dates of subsequent showers, if any, 14 to 10 days or so before rust appearance within brackets	Date of rust appearance, as reported from the station. Incidence within brackets	Area or stations where rust had appeared at least 15 days earlier. Date of rust appearance or incidence within brackets
				ASSAM		
				Dhubri (115 ft. above sea level)		
78	1936-37 ...	4,920	December 16 ...	†	(January 23; 0.40 per cent)	Central Nepal (December 6; 10 per cent)
	1936-37 ...	6,560	December 16 ...	†	(January 23; 0.40 per cent)	Central Nepal (December 6; 10 per cent)
				CENTRAL PROVINCES		
				Jubbulpore (1,289 ft. above sea level)		
79	1934-35 ...	1,640	January 24 ...	January 24—27 ... ... (February 3—7)	February 17 ...	Pottangi (January 8—9; 5-100 per cent)
80	1934-35 ...	3,280	January 27 ...	... (February 3—7)	February 17 ...	Pottangi (January 8—9; 5-100 per cent)
81	1934-35 ...	4,920	January 18 ...	January 21—24 ... ... (February 3—7)	February 17 ...	Pottangi (January 8—9; 5-100 per cent)
82	1933-34 ...	6,560	January 5 ...	January 6—10* ... (January 17—20)	January 30 ...	Chitaldroog (December 15; over 60 per cent)

No slides were exposed
The wind referred to in ... ıded ... pore howers in Table XIV b ... ırked with a query

TAB: X] con

Map number	Year	Height of the wind in feet above sea level	Date of wind trajectory	Dates of spore shower soon after the wind. Dates of subsequent showers, if any, 14 to 10 days or so before rust appearance within brackets	Date of rust appearance, as reported from the station. Incidence within brackets	Area or stations where rust had appeared at least 15 days earlier. Dates of rust appearance or incidence within brackets
				Khandwa (1,044 feet above sea level)		
83	1933-34 ...	1,640	January 4 ...	January 2—6**, 6—9 (January 9—13) ...	January 24 ...	Pottangi (January 13—14 ; 100 per cent)
84	1933-34 ...	3,280	December 24 ...	‡December 22—25 § (January 9—13) ...	January 24 ...	Pottangi (January 13—14 ; 100 per cent)
				MADRAS		
				Coimbatore (1,341 feet above sea level)		
85	1935-36 ...	1,640	November 12 ...	November 12—15, 15—19 (November 22—26) ...	December 9 ...	Nilgiris (September 20 ; 65-100 per cent)
86	1935-36 ...	3,280	November 14 ...	November 15—19 (November 22—26) ...	December 9 ...	Nilgiris (September 20 ; 65-100 per cent)
87	1935-36 ...	4,920	November 13 ...	November 15—19 (November 22—26) ...	December 9 ...	Nilgiris (September 20 ; 65-100 per cent)
	1935-36 ...	6,560	November 13 ...	November 15—19* (November 22—26) ...	December 9 ...	Nilgiris (September 20 ; 65-100 per cent)
88	1935-36 ...	6,560	November 17 ...	November 22—26 (November 22—26) ...	December 9 ...	Kodaikanal (September 28 ; 20-40 per cent)

** The spore shower might have occurred on January 2 or 3, due to some earlier wind
‡ The spore shower might have occurred on December 22 or 23, due to some earlier wind
§ The wind referred to in the previous column has not been included in the list of those followed by spore showers in Table XIV because of its height
* The wind referred to in the previous column has been included in the list of those followed by spore showers in Table XIV but marked with a query

X ontd.

Map number	Year	Height of the wind in feet above sea level	Date of wind trajectory	Dates of spore shower soon after the wind. Dates of subsequent showers, if any, 14 to 10 days or so before rust appearance within brackets	Date of rust appearance, as reported from the station. Incidence within brackets	Area or stations where rust had appeared at least 15 days earlier. Dates of rust appearance or incidence within brackets
				MYSORE STATE		
				Mandya (2,580 feet above sea level)		
89	1936-37 ...	3,280	March 2 ...	**March 1—4* ... ... (March 1—4)	March 15 ...	Kodaikanal (October 10 ; 40-60 per cent) Anthiyur (February 13) Coimbatore (November 16) Coonoor (September 28 ; 100 per cent)
	1936-37 ...	4,920	March 2 ...	**March 1—4* ... ... (March 1—4)	March 15 ...	Kodaikanal (October 10 ; 40-60 per cent) Anthiyur (February 13) Coimbatore (November 16) Coonoor (September 28 ; 100 per cent)
	1936-37 ...	6,560	March 2 ...	**March 1—4 § ... ... (March 1—4)	March 15 ...	Nilgiris (September 28 ; 100 per cent)

* The wind referred to in the previous column has been included in the list of those followed by spore showers in Table XIV but marked with a query.
** The spore shower might have occurred on March 1, due to some earlier wind.
§ The wind referred to in the previous column has not been included in the list of those followed by spore showers in Table XIV because of its height.

XIV

S ar of data of the d **brown us** *ng 19 19*

Year	Date of rust appearance, as reported from the station.* Incidence where known within brackets	Dates of spore shower, if any, nearly 4 to 2 weeks before rust appearance; those only 14 to 10 days or so earlier in brackets	Period of wind trajectories	Number of winds: Studied	Number of winds: Found to be relevant† a	b	c	d	Number of relevant winds followed by spore showers	Stations of earlier rust appearance passed over by relevant winds. Ref. Tables X and XIII	Total number of possibly‡ relevant winds, *i.e.*, from the hills. Those followed by spore showers within brackets
			PUNJAB								
			1. Lyallpur								
1932-33	Middle of April ...	March 29 to April 1 ...	March 20 to April 5 ...	56	0	0	0	2	1+1 §	Simla ...	15 (1+5 §)
1933-34	March 1st week ...	February 16—20 ...	February 1—15 ...	59	0	0	1	1	1	Simla, Benares	0
1934-35	March 15 ...	February 18—21 ...	February 15—28 ...	53	0	1	2	0	1+2 § ...	Simla	14 (3+1 §)
1935-36	March 27 ...	March 6—10 (March 10—14) ...	February 25 to March 12	54	0	0	3	9	12	Peshawar ...	9 (9)
1936-37	March 20 ...	March 1—4 (March 8—11) ...	February 20 to March 7	54	5	1	0	0	5+1 § ...	Gurdaspur ... Hoshiarpur	10 (8+1 §)
1937-38	April 1 ...	No spores ...	March 1—16 ...	54	0	0	0	0	...	...	8

* Observations made by members of the Rust Research Staff or occasionally the writer. Range of crop infection relates to different fields and on different varieties in that locality

† a, b, c, d refer to such winds as had started from or passed over at least one station where the rust had appeared earlier, by 8 weeks or more, nearly 4 to 8 weeks, 3 to 4 weeks and 15 to 21 days respectively

‡ As explained in the text as well as in table XV.

§ Represents number of winds followed by spore showers during the periods not strictly in accordance with the heights of the winds concerned. Ref. sub-head 10 (*ii*).

TABLE X[illegible]d

Year	Date of rust appearance, as reported from the station. Incidence where known within brackets	Dates of spore shower, if any, nearly 4 to 2 weeks before rust appearance; those only 14 to 10 days or so earlier in brackets	Period of wind trajectories	Number of winds: Studied	Found to be relevant: a	b	c	d	Number of relevant winds followed by spore showers	Stations of earlier rust appearance passed over by relevant winds. Ref. Tables X and XIII	Total number of possibly relevant winds, *i.e.*, from the hills. Those followed by spore showers within brackets
			2. Hoshiarpur**								
1933-34	January 1st week ...	No spores ...	December 1—15 ...	59	0	0	1	5	0	Simla ...	11
1934-35	February 1st half ...	January 14—17; January 29 to February 1.	January 1—31 ...	119	0	1	1	0	1	Western Nepal ...	44 (31+10 ?)
1936-37	January 15 ...	No spores (January 5—8) ...	December 15—31 ...	66	0	0	17	15	0	Gurdaspur ...	22
			3. Rawalpindi**								
1933-34	April 19 ...	April 1—5 ... (April 5—8) ...	March 19 to April 2 ...	45	0	0	0	0	...	...	7 (7)
1934-35	March 3rd week ... (March 24; traces)	No spores	February 15 to March 5	57	0	0	0	0	...	...	5
			4. Karnal								
1933-34	January 15 ...	No spores ...	December 14—29 ...	63	0	3	0	0	0	Simla ...	6
1934-35	February 26 ...	No spores ...	January 26 to February 8	52	0	1	0	1	0	Simla. Western Nepal ...	7

Situated

XIV

Year	Date of rust appearance, as reported from the station. Incidence where known within brackets	Dates of spore shower, if any, nearly 4 to 2 weeks before rust appearance ; those only 14 to 10 days or so earlier in brackets	Period of wind trajectories	Number of winds: Studied	Found to be relevant: a	b	c	d	Number of relevant winds followed by spore showers	Stations of earlier rust appearance passed over by relevant winds. Ref. Tables X and XIII	Total number of possibly relevant winds, i.e., from the hills. Those followed by spore showers within brackets
			4. Karnal—*contd.*								
1935-36	January 19 ...	December 26—30 ; January 2—6 (January 6—9)	December 19 to January 2	59	0	0	0	0	...	...	16 (13+2?)
1936-37	January 22 ...	December 28—31 ; January 4—7 (January 7—11)	December 22 to January 6	60	0	0	0	0	...	...	30 (21+4?)
1937-38	February 13 ...	No spores	January 13—28 ...	50	0	0	0	0	...	...	24
			SIND								
			5. Sakrand								
1933-34	March 10 ...	February 13—17 ...	February 10—25 ...	61	0	0	0	0	...	...	0
1934-35	March 4 ...	No spores ...	February 4—17 ...	56	0	0	0	0	...	...	0
1935-36	March 13 ...	February 25—28 ...	February 12—27 ...	44	0	0	0	0	...	...	0
1936-37	March 20 ...	February 28 to March 1	February 20 to March 7	56	1	0	0	0	0	Central Nepal, Shahjahanpur	0

TAB. XIV.

Year	Date of rust appearance, as reported from the station. Incidence where known within brackets	Dates of spore shower, if any, nearly 4 to 2 weeks before rust appearance; those only 14 to 10 days or so earlier in brackets	Period of wind trajectories	Number of winds					Number of relevant winds followed by spore showers	Stations of earlier rust appearance passed over by relevant winds. Ref. Tables X and XIII	Total number of possibly relevant winds, *i.e.*, from the hills. Those followed by spore showers within brackets
				Studied	Found to be relevant						
					a	b	c	d			
			DELHI								
			6. Delhi								
1937-38	February 15 ...	No spores	January 15—31 ...	61	0	0	0	1	0	Gorakhpur, Pusa	14
			UNITED PROVINCES								
			7. Agra								
1932-33	February 19 ...	February 4—7 ...	January 20 to February 4	64	0	0	0	0	...	...	22 (2+1 ?)
1933-34	February 1 ...	January 10—14 (January 21—24) ...	January 1—15 ...	54	0	4	1	1	4+1 ?	Simla, Gonda, Gorakhpur, Hyderabad, Pottangi	2 (1+1 ?)
1934-35	February 2 ...	No spores ...	January 2—18 ...	66	0	1	0	0	0+1 ?	Western Nepal	18
1935-36	February 5 ...	January 4—6; 6—8 and 8—10	January 5—19 ...	60	0	0	0	0	...	...	12 (3+1 ?)
1936-37	February 15 ...	{No spores / February 3—6}	January 15—30 ...	64	0	3	0	0	0	Gurdaspur, Bareilly	9
1937-38	February 3 ...	No spores ...	January 3—18 ...	61	0	0	0	0	...	...	13

XIV

Year	Date of rust appearance as, reported from the station. Incidence where known within brackets	Dates of spore shower, if any, nearly 4 to 2 weeks before rust appearance; those only 14 to 10 days or so earlier in brackets	Period of wind trajectories	Number of winds: Studied	Found to be relevant: a	b	c	d	Number of relevant winds followed by spore showers	Stations of earlier rust appearance passed over by relevant winds. Ref. Tables X and XIII	Total number of possibly relevant winds, *i.e.*, from the hills. Those followed by spore showers within brackets
			8. Gorakhpur**								
1933-34	February 1st or 2nd week (December 14; traces)	December 30 to January 4 November 25—28 (December 2—6)	November 14—28 ...	59	0	0	0	0	...	...	34 (5+5 ?)
1934-35	December 31 ... (December 31; 40—50 per cent)	No spores ...	December 1—5 ...	17	0	0	0	1†	0	Central Nepal	0
1935-36	December 16 ...	November 29 to December 2 (December 2—5)	November 16—30 ...	55	0	0	0	0	...	...	34 (26+6 ?)
1936-37	No information ... (January 5—6; 0-10 per cent)	December 5—8 ...	November 25 to December 10	47	0	0	0	9*	1+6 ?	Central Nepal	19 (1+1 ?)
1937-38	January 10 ... (January 7; 0-3 per cent)	December 13—16 ... (December 20—23)	December 3—18 ...	58	0	0	0	0	...	...	26 (7+14 ?)

** Situated at foot-hills
† In central Nepal nearly 30 per cent crop infection was observed on December 23 to 24, 1934
* In Central Nepal 0-10 per cent crop infection was observed on December 6, 1937

TABLE XIV d.

Year	Date of rust appearance, as reported from the station. Incidence where known within brackets	Dates of spore shower, if any, nearly 4 to 2 weeks before rust appearance; those only 14 to 10 days or so earlier in brackets	Period of wind trajectories	Number of winds					Number of relevant winds followed by spore showers	Stations of earlier rust appearance passed over by relevant winds. Ref. Tables X and XIII	Total number of possibly relevant winds, i.e., from the hills. Those followed by spore showers within brackets
				Studied	Found to be relevant						
					a	b	c	d			
			BIHAR								
			9. Pusa								
1932-33	December 29 ...	December 1—5 (December 15—19) ...	November 30 to December 14	59	0	0	0	0	...	...	22 (7+7?)
1933-34	December 20 ...	November 27—30 ...	November 20 to December 4	60	0	0	0	1	0	Simla	19 (0+7?)
1934-35	December 9 ...	November 5—8 8—12 and 12—15 ...	November 9—24 ...	64	0	0	0	0	...	...	20 (4+2?)
1935-36	December 23 ...	December 6—10 ...	November 23 to December 7	58	0	0	0	10‡	2+6?	Central Nepal	26 (14+11?)
1936-37	January 5 ...	December 11—15 December 22—25	December 5—20 ...	62	0	0	0	21*	3+6?	Central Nepal	12 (3+3?)
1937-38	January 9 ...	No spores ...	December 9—24 ...	57	0	0	0	0	...	...	42

* In Central Nepal 0-10 per ... crop infection w... ...rved o... De...mber ..., 1937
‡ In Central Nepal 25 and 4... cent crop infecti... observ... Dece...ber 30 and

TAB XIV

Year	Date of rust appearance, as reported from the station. Incidence where known within brackets	Dates of spore shower, if any, nearly 4 to 2 weeks before rust appearance ; those only 14 to 10 days or so earlier in brackets	Period of wind trajectories	Number of winds					Number of relevant winds followed by spore showers	Stations of earlier rust appearance passed over by relevant winds. Ref. Tables X and XIII	Total number of possibly relevant winds, i.e., from the hills. Those followed by spore showers within brackets
				Studied	Found to be relevant						
					a	b	c	d			
			10. Sabour								
1932-33	March 2nd week ... (March 13 ; 100 per cent)	January 26—29 ... January 29 to February 2	January 15—30 ...	51	0	0	0	0	0	...	21 (20)
1933-34	January 18 ... (January 23 ; 60 per cent)	December 21—24 ...	December 18—25 ...	32	0	4	0	0	0+1 ?	Simla ...	7 (2+4 ?)
1934-35	February 28 ...	February 11—14 ... (February 14—18)	January 28 to February 10	56	6	10	16	14	46	Central and Western Nepal, Pusa, Patna, Fyzabad, Gonda, Gorakhpur, Bahraich, Bareilly, Simla, Benares, Cawnpore	0
1935-36	No information ... (January 1 ; traces)	No spores	December 1—18 ...	67	0	0	0	17†	0	Central Nepal	4
1936-37	Early in January ...	No spores	December 5—20 ...	61	0	0	0	27‡	0	Central Nepal	5

ı Central Ne ıd 40 per ıt croı ioı ıbserved on December 30 a
Central Neı 0 per ceı ·op in ·rved on December 6, 1936

TABLE XIV—*contd*

Year	Date of rust appearance, as reported from the station. Incidence where known within brackets	Dates of spore shower, if any, nearly 4 to 2 weeks before rust appearance; those only 14 to 10 days or so earlier in brackets	Period of wind trajectories	Number of winds: Studied	Found to be relevant: a	b	c	d	Number of relevant winds followed by spore showers	Stations of earlier rust appearance passed over by relevant winds. Ref. Tables X and XIII	Total number of possibly relevant winds, *i.e.*, from the hills. Those followed by spore showers within brackets
			10. Sabour—*contd.*								
1937-38	February End of 2nd week	January 23—27 ...	January 15—31 ...	57	0	0	4	7	0+4 ?	Gauhati, Dhubri, Puse, Gorakhpur, Pilibhit*	23 (4+5 ?)
			BENGAL								
			11. Mymensingh								
1936-37	Did not appear ... (February 13; traces-75 per cent)	§ ...	December 15—30 ...	47	0	0	3‡	2‡	§	Central Nepal	1
			ASSAM								
			12. Dhubri**								
1936-37	No information ... (January 23; 0-40 per cent)	§	December 5—20 ...	52	0	0	0	6‡	†	Central Nepal	2

* At this station 2 per cent crop infection was observed on January 3
‡ In Central Nepal 0 to 10 per cent crop infection was observed on December 6, 1936
§ No slides were exposed at this station
** Situated at foot-hills

TABLE X

Year	Date of rust appearance, as reported from the station. Incidence where known within brackets	Dates of spore shower, if any, nearly 4 to 2 weeks before rust appearance; those only 14 to 10 days or so earlier in brackets	Period of wind trajectories	Number of winds: Studied	Number of winds: Found to be relevant: a	b	c	d	Number of relevant winds followed by spore showers	Stations of earlier rust appearance passed over by relevant winds. Ref. Tables X and XIII	Total number of possibly relevant winds, *i.e.*, from the hills. Those followed by spore showers within brackets
			CENTRAL PROVINCES								
			13. Jubbulpore								
1933-34	January 30 ...	January 6—10 (January 17—20) ...	December 28 to January 13	61	0	0	6	2	2+3?	Pottangi, Gorakhpur, Pusa, Chitaldroog	0
1934-35	February 17 ... (February 25; 20 to 30 per cent)	January 31 to February 3 (February 3—7)	January 15 to February 1	65	0	7	0	0	5	Pusa, Pottangi, Western and Central Nepal	7 (3)
1936-37	January 19 ...	No spores	December 19 to January 3	64	0	0	0	16	0	Bareilly, Gonda*, Fyzabad, Central Nepal	5
			14. Khandwa								
1933-34	January 24 ...	January 6—9 (January 9—13) ...	December 24 to January 7	46	0	0	2	1	1	Pottangi	0
			BOMBAY-DECCAN								
			15. Dharwar								
1935-36	January 15 ...	December 21—25 ...	December 15—31 ...	55	0	0	0	0	...	...	0

At thi ition p infec bserved iry 2

XIV

Year	Date of rust appearance, as reported from the station. Incidence where known within brackets	Dates of spore shower, if any, nearly 4 to 2 weeks before rust appearance ; those only 14 to 10 days or so earlier in brackets	Period of wind trajectories	Number of winds: Studied	Found to be relevant: a	b	c	d	Number of relevant winds followed by spore showers	Stations of earlier rust appearance passed over by relevant winds. Ref. Tables X and XIII	Total number of possibly relevant winds, *i.e.*, from the hills. Those followed by spore showers within brackets
			HYDERABAD-DECCAN								
			16. Himayatsagar near Hyderabad								
1933-34	Middle of January (January 20—21 ; 1-100 per cent)	December 22—27 ... November 30 to December 7 (December 7—11)	November 20 to December 5	48	0	0	0	0	...	...	0
			MADRAS								
			17. Coimbatore**								
1933-34	December 26 ... (December 27—28; 10-40 per cent)	No spores ...	November 24 to December 8	52	0	0	0	6	0	Ootacamund, Coonoor (Nilgiris)	1
1934-35	January 21 ...	December 27—31 ...	December 21 to January 5	59	0	8	5	0	4+7?	Ootacamund, Coonoor (Nilgiris)	0
1935-36	December 9 ...	November 15—19 ... (November 22—26)	November 9—23 ...	57	16	0	0	0	7+7?	Nilgiris, Kodaikanal	0
1936-37	November 16 ...	October 22—26 ...	October 16—31 ...	57	2	5	0	0	3+1?	Coonoor, Kodaikanal	0
1937-38	September 28 ...	No spores	August 28 to September 20	88	2	0	0	0	0	Ootacamund (Nilgiris)	0

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TABLE X

Year	Date of rust appearance, as reported from the station. Incidence where known within brackets	Dates of spore shower, if any, nearly 4 to 2 weeks before rust appearance; those only 14 to 10 days or so earlier in brackets	Period of wind trajectories	Number of winds: Studied	Number of winds: Found to be relevant				Number of relevant winds followed by spore showers	Stations of earlier rust appearance passed over by relevant winds. Ref. Tables X and XIII	Total number of possibly relevant winds, *i.e.*, from the hills. Those followed by spore showers within brackets
					a	b	c	d			
			MYSORE								
			18. Mandya** ...								
1935-36	October 16 ...	September 26—30 ...	September 10—30	82 + 8*	0	0	0	8*	0† 1*	Kodaikanal, Nilgiris	0
1936-37	March 15 ...	February 25 to March 1 (March 1—4)	February 15 to March 2	44	7	0	0	0	1 † 5 ?	Nilgiris, Palnis, Coimbatore, Anthiyur	0
			Total ...	3,412	39	49	62	184	101† 52 ?		648 (195 † 91?)

TABLE XV—*contd.*

Serial number	Province and Station. Altitude in feet above sea level, within brackets. Period of study	Height of winds in feet above sea level	Total number of winds studied	Relevant winds. (*a*) Total number, (*b*) Number for specified height only followed by spore showers, (*c*) Number along with winds at other heights followed by spore showers			Possibly† Relevant winds : (*i-iv*) From different hills, (*v*) Number for specified height only followed by spore showers, (*vi*) Number along with winds at other heights followed by spore showers					
				(*a*)	(*b*)	(*c*)	(*i*)	(*ii*)	(*iii*)	(*iv*)	(*v*)	(*v*)
3	Rawalpindi* (1,674)	3,280	34	0	0	0	0	2	0	0	0	1
	2 years ...	4,920	34	0	0	0	0	2	0	0	0	1
		6,560	34	0	0	0	0	7	1	0	4	1
4	Karnal (900) ...	1,640	73	5	0	0	0	10	21	0	0	11
	5 years	3,280	73	0	0	0	0	7	15	0	0	9
		4,920	70	0	0	0	0	10	11	0	0	9
		6,560	68	0	0	0	0	6	3	0	0	5
	SIND											
5	Sakrand (120) ...	1,640	49	1	0	0	0	0	0	0	0	0
	4 years ...	3,280	53	0	0	0	0	0	0	0	0	0
		4,920	57	0	0	0	0	0	0	0	0	0
		6,560	58	0	0	0	0	0	0	0	0	0
	DELHI											
6	Delhi (714) ...	1,640	15	1	0	0	0	3	3	0	0	0
	1 year ...	3,280	14	0	0	0	0	1	2	0	0	0
		4,920	17	0	0	0	0	2	1	0	0	0
		6,560	15	0	0	0	0	2	0	0	0	0
	UNITED PROVINCES											
	Agra (554) ...	1,640	92	7	0	3	0	11	28	0	6	0
	6 years ...	3,280	92	2	0	1	0	8	12	0	0	0
		4,920	92	0	0	0	0	6	8	0	0	0
		6,560	93	1	0	0	0	2	1	0	0	0

* Situated at foot-hills.

TABLE XV—*contd.*

Serial number	Province and Station. Altitude in feet above sea level, within brackets. Period of study	Height of winds in feet above sea level	Total number of winds studied	Relevant winds : (*a*) Total number, (*b*) Number for specified height only followed by spore showers, (*c*) Number along with winds at other heights followed by spore showers			Possibly Relevant winds (*i-iv*) From different hills, (*v*) Number for specified height only followed by spore showers, (*vi*) Number along with winds at other heights followed by spore showers					
				(*a*)	(*b*)	(*c*)	(*i*)	(*ii*)	(*iii*)	(*iv*)	(*v*)	(*vi*)
8	**Gorakhpur* (257)**	1,640	58	3	1	0	8	3	13	0	1	6
	5 years ...	3,280	52	2		0	16	2	11	0	0	11
		4,920	62	4	0	0	17	1	13	0	1	10
		6,560	64	1	0	0	10	3	16	0	1	9
	BIHAR											
9	**Pusa (188)** ...	1,640	87	12	0	0	22	2	11	0	0	5
	6 years ...	3,280	88	9	2	0	30	3	10	0	0	7
		4,920	93	7	0	1	20	1	7	0	0	8
		6,560	92	4	0	2	22	3	10	0	0	8
10	**Sabour (122)** ...	1,640	76	28	0	11	6	0	2	0	0	2
	6 years ...	3,280	78	26	0	10	10	0	3	0	0	7
		4,920	85	27	0	13	11	3	3	0	0	9
		6,560	85	24	0	12	11	0	11	0	0	8
	BENGAL											
11	**Mymensingh (62)**	1,640	13	1	‡	‡	0	0	0	0	‡	‡
	1 year ...	3,280	10	1	‡	‡	0	1	0	0	‡	‡
		4,920	10	1	‡	‡	0	0	0	0	‡	‡
		6,560	14	2	‡	‡	0	0	0	0	‡	‡
	ASSAM											
12	**Dhubri* (115)** ...	1,640	13	0	‡	‡	0	0	0	0	‡	‡
	1 year ...	3,280	14	0	‡	‡	0	0	1	0	‡	‡
		4,920	13	4	‡	‡	0	0	0	0	‡	‡
		6,560	12	2	‡	‡	0	0	1	0	‡	‡

* Situated at foot-hills

‡No slides were exposed at this station

TABLE XV—*contd.*

Serial number	Province and Station. Altitude in feet above sea level within brackets. Period of study	Height of winds in feet above sea level	Total number of winds studied	Relevant winds : (a) Total number, (b) Number for specified height only followed by spore showers, (c) Number along with winds at other heights followed by spore showers			Possibly Relevant winds : (i-iv) From different hills, (v) Number for specified height only followed by spore showers, (vi) Number along with winds at other heights followed by spore showers					
				(a)	(b)	(c)	(i)	(ii)	(iii)	(iv)	(v)	(vi)
	CENTRAL PROVINCES											
13	**Jubbulpore (1,289)**	1,640	51	10	1	2	0	1	8	0	3	0
	3 years ...	3,280	44	14	0	3	0	1	0	0	0	0
		4,920	46	4	0	1	0	1	0	0	0	0
		6,560	49	3	0	0	0	0	1	0	0	0
14	**Khandwa (1,044)** ...	1,640	14	2	1	0	0	0	0	0	0	0
	1 year ...	3,280	12	1	0	0	0	0	0	0	0	0
		4,920	10	0	0	0	0	0	0	0	0	0
		6,560	10	0	0	0	0	0	0	0	0	0
	BOMBAY-DECCAN											
15	**Dharwar (2,340)**	3,280	17	0	0	0	0	0	0	0	0	0
	1 year ...	4,920	17	0	0	0	0	0	0	0	0	0
		6,560	12	0	0	0	0	0	0	0	0	0
		9,840	9	0	0	0	0	0	0	0	0	0
	HYDERABAD-DECCAN											
16	**Himayatsagar (1,776)**	3,280	16	0	0	0	0	0	0	0	0	0
	1 year ...	4,920	16	0	0	0	0	0	0	0	0	0
		6,560	16	0	0	0	0	0	0	0	0	0

TABLE XV—*contd.*

Serial number	Province and Station. Altitude in feet above sea level, within brackets. Period of study	Height of winds in feet above sea level	Total number of winds studied	Relevant winds: (a) Total number, (b) Number for specified height only followed by spore showers, (c) Number along with winds at other heights followed by spore showers			Possibly Relevant winds: (i-iv) From different hills, (v) Number for specified height only followed by spore showers, (vi) Number along with winds at other heights followed by spore showers					
				(a)	(b)	(c)	(i)	(ii)	(iii)	(iv)	(v)	(vi)
	MADRAS											
17	**Coimbatore* (1,341)**	1,640	77	20	7	0	0	0	0	1	0	0
	5 years ...	3,280	82	2	0	1	0	0	0	0	0	0
		4,920	82	5	0	1	0	0	0	0	0	0
		6,560	72	17	4	1	0	0	0	0	0	0
	MYSORE											
18	**Mandya* (2,580)** ...	3,280	37	1	0	0	0	0	0	0	0	0
	2 years ...	4,920	36	4	1	0	0	0	0	0	0	0
		6,560	32	3	0	0	0	0	0	0	0	0
		9,840	21	0	0	0	0	0	0	0	0	0
	(Trajectories based on cloud observations)	9,840	7	7	1	0	0	0	0	0	0	0
		13,120	1	1	0	0	0	0	0	0	0	0
	TOTAL ...		3,412	334	25	76	183	196	268	1	23	172

* Situated at foot-hills

TABLE XVI

S y of data giv in Map Nos. 90 to 94 in relation to some of the winds con o eg as 'relevant' for the dissemination of **brown rust**

Map number	Year	Height of the wind in feet above sea level	Date of wind trajectory	Dates of spore shower soon after the wind. Dates of subsequent showers, if any, 14 to 10 days or so before rust appearance within brackets	Date of rust appearance, as reported from the station.	Area or station passed over by the winds. Date of rust appearance or incidence† where known within brackets
				PUNJAB		
				Karnal (900 feet above sea level)		
90	1935-36 ...	1,640	January 2 ...	January 2—6 ... ... (January 2—6 and 6—9)	January 19 ...	Peshawar, Lahore
	1935-36 ...	3,280	January 2 ...	January 2—6 ... ... (January 2—6 and 6—9)	January 19 ...	Peshawar, Lahore
	1935-36 ...	4,920	January 2 ...	January 2—6 ... ... (January 2—6 and 6—9)	January 19 ...	Lyallpur (March 27), Lahore
	1935-36 ...	6,560	January 2 ...	January 2—6 ... ... (January 2—6 and 6—9)	January 19 ...	Sind, Rajputana
91	1936-37 ...	3,280	January 3 ...	January 4—7 ... ... (January 7—11)	January 22 ...	Dehradun (February 23 ; 0-65 per cent)
	1936-37 ...	4,920	January 3 ...	January 4—7 ... ... (January 7—11)	January 22 ...	Ambala
	1936-37 ...	6,560	January 3 ...	January 4—7 ... ... (January 7—11)	January 22 ...	Ambala

TA XV

Map number	Year	Height of the wind in feet above sea level	Date of wind trajectory	Dates of spore shower soon after the wind. Dates of subsequent showers, if any, 14 to 10 days or so before rust appearance within brackets	Date of rust appearance, as reported from the station.	Area or station passed over by the winds. Date of rust appearance or incidence where known within brackets
				UNITED PROVINCES		
				Agra (554 feet above sea level)		
92	1932-33 ...	1,640	February 4 ...	February 4—7 ... ... (February 4—7)	February 19 ...	Punjab, Rajputana
	1932-33 ...	3,280	February 4 ...	February 4—7 ... ... (February 4—7)	February 19	Punjab, Rajputana
	1932-33 ...	4,920	February 4 ...	February 4—7 ... ... (February 4—7)	February 19 ...	Punjab, Rajputana
	1932-33 ...	6,560	February 4 ...	February 4—7 ... ... (February 4—7)	February 19 ...	Punjab, Rajputana
93	1935-36 ...	1,640	January 7 ...	January 6—8** and 8—10 ...	February 5 ...	Simla (April 10) (Dehradun (March 18 ; traces)
	1935-36 ...	3,280	January 7 ...	January 6—8** and 8—10 ...	February 5 ...	Lyallpur (March 27)
	1935-36 ...	4,920	January 7 ...	January 6—8** and 8—10 ...	February 5 ...	Sind, Rajputana
	1935-36 ...	6,560	January 7 ...	January 6—8** and 8—10 ...	February 5 ...	Sind, Rajputana

** The spore shower might have occurred on January 6, due to some earlier wind

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Map number	Year	Height of the wind in feet above sea level	Date of wind trajectory	Dates of spore shower soon after the wind. Dates of subsequent showers, if any, 14 to 10 days or so before rust appearance within brackets	Date of rust appearance, as reported from the station.	Area or station passed over by the winds Date of rust appearance or incidence where known within brackets
				BIHAR		
				Pusa (188 feet above sea level)		
94	1934-35 ...	1,610	November 11 ...	November 12—15 ...	December 9 ...	Gauhati, Dhubri
	1934-35 ...	3,230	November 11 ...	November 12—15 ...	December 9 ...	Ambala, Bareilly (January 19 ; traces), Shahjahanpur (February 11)
	1934-35 ...	4,920	November 11 ...	November 12—15 ...	December 9 ...	Lyallpur (March 15); Delhi, Gorakhpur (December 31 ; 40-50 per cent)
	1934-35 ...	6.560	November 11 ...	November 12—15 ...	December 9 ...	Delhi, Shahjahanpur, Bahraich, Gonda, Gorakhpur

TABLE XVII

Serial No.	Province	Name of station	Earliest date of rust appearance, as reported from the station. Incidence† within brackets	Usual period of rust appearance
1	PUNJAB ...	Gurdaspur* ...	December 4	March 2nd week
2		Hoshiarpur* ...	January 1st week ...	February 1st week
3		Rawalpindi* ...	March 3rd week ...	April 2nd week
4		Lyallpur ...	January 3rd week ...	March 3rd—4th week
5		Khanewal ...	February 24	March 2nd—4th week
6		Karnal ...	January 15	January 4th week
7		Ambala ...	(March 15; 1-25 per cent)	March 1st—4th week
8		Jullundar ...	(March 12; 0-10 per cent)	March 1st—4th week
9	N.-W. F. PROVINCE ...	Peshawar* ...	January 2nd week ...	January 2nd week
10	SIND ...	Sakrand ...	March 4	March 2nd week
11	DELHI ...	Delhi ...	February 15 ... ... (February 13; 10-20 per cent)	February 4th week
12	UNITED PROVINCES ...	Dehradun* ...	February 23 ... ... (February 12; 20-40 per cent)	March 4th week
13		Gorakhpur* ...	December 16 ... ... (December 14; traces)	December 4th week
14		Mailani* ...	(January 5; 80 per cent) ...	December End—Early January
15		Gainsari* ...	(December 12; 10 per cent)	December 2nd—3rd week
16		Nautanwa* ...	(December 13; one leaf) ...	December 3rd week
17		Nepalganj Road*	(December 11; traces) ...	December 3rd week
18		Bellrein* ...	(December 27; 0-40 per cent)	Early January—Early February
19		Kathgodam* ...	(February 3; Heavy) ...	February 1st—4th week
20		Haldwani* ...	(January 3rd week) ... (February 3; common)	February 2nd week

† Observations made by members of the Rust Research Staff or occasionally the writer. Range of crop infection relates to different fields and on different varieties at that locality

* Situated at foot-hills

TABLE XVII—*contd.*

Serial No.	Province	Name of station	Earliest date of rust appearance, as reported from the station. Incidence within brackets	Usual period of rust appearance
21		**Shahjabanpur** ...	January 4th week ... (February 1-2; 60 per cent)	February 1st—2nd week
22		**Bareilly** ...	(December 23; 0-20 per cent)	January 1st week—February 1st week
23		**Pilibhit** ...	(December 25; traces) ...	December End—Early Januar
24		**Barabanki** ...	(December 9; traces) ...	January 1st—2nd week
25		**Gonda** ...	(December 10; traces) ...	December 3rd—4th week
26		**Bahraich** ...	(December 31; 0-5 per cent)	December 3rd—4th week
27		**Fyzabad** ...	December 4th week ...	January Middle—Early February
28		**Agra** ...	January 18	February 1st week
29		**Cawnpore** ...	February 1st week ... (February 19; 90-100 per cent)	February—March
30		**Lucknow** ...	(January 31; 80 per cent) ...	January 2nd week—February 2nd week
31		**Allahabad** ...	January 14	January End—February Midd
32		**Benares** ...	January 19 ... ... (January 12; traces)	January 3rd—4th week
33		**Sitapur** ...	(December 29; 0-5 per cent)	January 1st week—February 1st week
34		Jhansi ...	February 20 ... ... (February 21; 0-10 per cent)	February 3rd—4th week
35	**BIHAR** ...	**Raxaul*** ...	(December 27; 2-3 per cent)	January 1st—2nd week
36		**Jaynagar*** ...	(December 24; 1 per cent)	January 1st—3rd week
37		Jogbani* ...	(January 15; 0-5 per cent)	January 3rd—4th week
38		**Motihari*** ...	(January 10; traces—60 per cent)	January 2nd—3rd week
39		**Pusa** ...	December 9	December 4th week
40		**Patna** ...	(January 8; traces) ...	January 2nd week—February 1st week

* Situated at foot-hills

TABLE XVII—*contd.*

Serial number	Province	Name of station	Earliest date of rust appearance, as reported from the station. Incidence within brackets	Usual period of rust appearance
41		**Sabour** ...	(January 1 ; traces) ...	January 2nd—3rd week
42		**Katihar** ...	(December 17 ; one leaf) ...	January 2nd—4th week
43		**Sitamarhi** ...	(January 13 ; 5-50 per cent)	January 2nd—3rd week
44	**BENGAL** ...	**Malda** ...	(January 21 ; 30 per cent) ...	January 3rd—4th week
45		**Cooch-Behar** ...	(February 1 ; traces) ...	February 1st week
46		**Mymensingh** ...	(February 13 ; traces—75 per cent)	Early February
47	**ASSAM** ...	**Dhubri*** ...	(January 18—19 ; 0-75 per cent)	January 2nd—3rd week
48		Fakirganj* ...	(January 26 ; traces) ...	January End—Early February
49	**RAJPUTANA** ...	**Ajmer** ...	February 26	March 1st—2nd week
50		**Sri Ganganagar†**	March 1st week ...	...
51		**Jodhpur‡** ...	(March 8 ; traces) ...	...
52	**CENTRAL PROVINCES** ...	**Jubbulpore** ...	January 19	February 1st week
53		**Nagpur‡** ...	(March 6 ; 1 per cent) ...	...
54		**Khandwa** ...	January 24	February 4th week
55		**Piparia‡** ...	(January 11 ; traces) ...	...
56		**Powarkhera†** ...	January 28	...
57		**Saugor** ...	(February 24 ; 5-10 per cent)	February 3rd week—March 2nd week
58	**BOMBAY-DECCAN** ...	**Dharwar†** ...	January 15	...
59		**Dohad†** ...	February 25	...
60		**Baroda** ...	January 4th week ...	February 2nd—3rd week
61		**Broach†** ...	February 16	...
62		**Jagudan** ...	February 7	February 1st—4th week
63		**Amreli†** ...	February 9	...

* Situated at foot-hills
† This rust was reported only once
‡ This rust was observed only once

TABLE XVII—*contd.*

Serial number	Province	Name of station	Earliest date of rust appearance, as reported from the station. Incidence within brackets	Usual period of rust appearance
64	**HYDERABAD-DECCAN** ...	**Parbhani‡** ...	(January 21 ; 1-2 per cent) ...	...
65		**Himayatsagar** ...	January 1st week ... (January 20—21 ; 1-100 per cent)	January 1st—2nd week
66	**MADRAS** ...	**Coimbatore§** ...	September 28§	December 2nd week
67		**Vellakinar*** ...	(January 19 traces—50 per cent)	January 1st—2nd week
68		**Anthiyur†** ...	February 13	...
69		**Udumalpet‡** ...	(March 9 ; 0-5 per cent) ...	...
70	**MYSORE STATE**	**Mandya*** ...	October 16+	January 2nd week
71		**Hiriyur* (Chitaldroog)** ...	(November 30 ; 5 per cent)	November End

‡ This rust was observed only once
* Situated at foot-hills
†This rust was reported only once
§ On wheat sown in miniature plots during June-July 1937, at the request of the writer
+ On wheat sown in a miniature plot during August 1935, at the request of the writer

EXPLANATORY NOTES ON MAP Nos. 55—34. Ref. TABLES XIII AND XVI.

(*i*) In order to economise space only portions of maps showing the wind-trajectories have been included.

(*ii*) The scale of each map is 1 inch=341·3 miles.

(*iii*) Shaded portions represent hills and hilly tracts.

(*iv*) Each wind-trajectory bears the label A, B, or C etc., representing heights of 1640, 3280, 4920 feet above sea level respectively. These heights have been mentioned in the foot-notes to each map.

(*v*) Wherever no date of rust appearance was reported from the station concerned information, if available, regarding the incidence of rust on the date of observation by the writer or a member of the Rust Research Staff is given within brackets.

PART FOUR

Dissemination of *Puccinia glumarum* (Schm.) Erikss. & Henn.

18. Review of literature

There are very few references in literature to the dissemination of *P. glumarum*, the yellow or stripe rust. While discussing the annual recurrence of this rust in the neighbourhood of Cambridge, the writer [Mehta, 1923] recorded the presence of viable uredospores during the greater part of the winter of 1920-21. It was also pointed out that this rust thrives best at comparatively low temperatures and unlike black and brown rusts is unable to withstand warm weather.

The writer [Mehta, 1925] stated that outbreaks of this rust are probably caused by uredospores blown down from the hills where it survives during summer. In a later article [Mehta, 1929] the writer observed that early infection of the wheat crop by this rust from infected self-sown plants at Muktesar (nearly 7,500 ft. above sea level, Kumaon hills) and places similarly situated is probably responsible for outbreaks in the plains.

Sanford and Broadfoot [1932] suggested that the annual appearance of stripe rust (*P. glumarum*) in Alberta originates from wind-borne uredospores from the states of Washington, Idaho and possibly Montana.

Later, the writer [Mehta, 1933] stated that uredospores of this rust had been caught at several stations well in advance of local outbreaks.

With regard to the distribution of *Puccinia glumarum*, Stakman [1934] pointed out that in the United States it is almost entirely absent from the Mississippi Valley and is restricted to the extreme south-west, to the Pacific Coast and to fairly high elevations on the edge of the Plains region. He observed that the range of this rust may be limited by climatic factors.

According to Newton and Johnson [1936] *Puccinia glumarum* has a more limited distribution in Canada than the other cereal rusts, being confined to British Columbia, Alberta and the western half of Saskatchewan.

Săvulescu [1938] remarked that in Rumania the principal sources of infection by all the three rusts of wheat are the air-borne uredospores from surrounding wheat-growing countries.

The writer [Mehta, 1939, 1940] referred to the foci of infection, wherefrom this rust is probably disseminated to the plains in the north. It has also been stated that this rust is not found in the plains of Peninsular India whereas it is common in the north and some other parts of the country as well as in hills in the south, i.e. the Nilgiris and Palnis.

19. Study of dissemination with the help of aeroscope-slides

Full information regarding this study is given in Tables XVIII and XIX.

20. Study of balloon and kite-slides

As stated before, exposure of slides on balloons and kites was carried out only at the Agra Observatory. The data obtained from this study are given in Table XX.

21. Study of dissemination with the help of wind-trajectories

Since 1932, 2,977 wind-trajectories have been studied in connection with the dissemination of yellow rust to representative stations.

As with the other two rusts, the relevancy of these winds was carefully scrutinized in relation to the dates of spore showers and of rust appearance at these stations. Only representative trajectories are reproduced on Map Nos. 95 to 118 and full information regarding the winds is supplied as foot-notes. The details given in the maps are summarized in Table XXI.

Data regarding the total number of trajectories studied, the number of winds found 'relevant' as well as those 'possibly relevant', for all the four heights taken together, are given in Table XXII. Information regarding the relevancy of winds of different heights is summarized in Table XXIII.

22. Discussion

Observations made by the writer in Parts Two and Three apply, in a general way, to this rust as well. The various aspects of its dissemination are briefly discussed below :—

(i) *Dates of rust appearance in relation to spore showers*

Uredospores of this rust soon become discoloured and their detection on aeroscope-slides, therefore, is rendered more difficult than those of the other two rusts. Nevertheless spores were observed on slides exposed at several stations, well in advance of rust appearance on the local crops.

Year after year yellow rust was absent from the plains of Baroda, Gujerat-Kathiawar as well as of Peninsular India although spore showers occurred at 16 stations as revealed by the study of aeroscope-slides. This is largely due to the fact that this rust thrives best at comparatively low temperatures. The weekly range and average maximum and minimum temperatures of 12 such stations, where spores of this rust were caught from time to time, are given in Appendix D*. For comparison the temperatures of five representative stations in the north and central parts of the country for one month before the appearance of this rust during a period of three years are given in Appendix E.

As stated in Parts Two and Three it is difficult to explain the absence of spore showers 4 to 2 weeks before rust outbreaks at some of the stations in the north. This matter is discussed under General Discussion and Conclusions in Part Five.

(ii) *Spore showers in relation to winds*

The relevancy of winds in relation to spore showers followed by rust outbreaks was scrutinized on the lines described under sub-head 10 (ii) of Part Two.

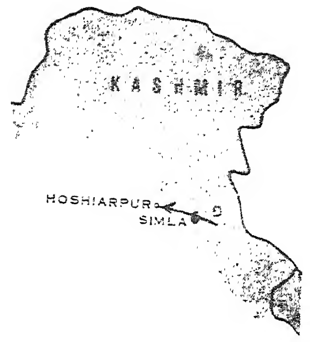
Some of the typical cases, in which spore showers were found soon after the winds or just prior to the commencement of the incubation period, have been dealt with in the maps. As with the other two rusts, for some of the stations no 'relevant' winds were found in one year or more although spore showers occurred 4 to 2 weeks before the local outbreaks. By way of illustration three cases are described here and some of the winds are reproduced on Map Nos. 119 to 123.

* Data from four stations were not available.

MAP NO. 95

MAP NO. 96

MAP NO. 97



95. LYALLPUR (605 ft. above sea level). YELLOW RUST. ORIGINAL MAP No. 233.

Date and height of trajectory in feet ... December 5, 1933 : B—3280.

Dates of spore shower soon after the wind ... No spores were caught.

Dates of spore shower 14—10 days before rust appearance ... ... No spores were caught.

Date of rust appearance ... ... December 31, 1933.

B—The wind was traceable from Kumaon hills and passed by the foot-hills of Simla. At Simla yellow rust had appeared on November 20, 1933.

96. HOSHIARPUR (702 ft. above sea level). YELLOW RUST. ORIGINAL MAP No. 2,016.

Date and heights of trajectories in feet ... February 4, 1938 : A—1640, B—3280, C—4920.

Dates of spore shower soon after the winds ... *

Dates of spore shower 14—10 days before rust appearance ... ... No spores were caught.

Date of rust appearance ... ... February 22, 1938.

A—The wind was traceable from Kashmir and passed near Gurudaspur where yellow rust had appeared on January 20, 1938.

B & C—The winds were traceable from Kashmir and passed over Gurudaspur where yellow rust had appeared on January 20, 1938.

* Slide exposed during February 4—9 was found entirely broken and could not, therefore, be examined.

97. HOSHIARPUR (702 ft. above sea level). YELLOW RUST. ORIGINAL MAP No. 1,520.

Date and height of trajectory in feet ... December 10, 1936 : D—6560.

Dates of spore shower soon after the wind ... No spores were caught.

Dates of spore shower 14—10 days before rust appearance ... ... No spores were caught.

Date of rust appearance ... ... January 5, 1937.

D—The wind was traceable from U.P. hills and passed over Simla where yellow rust had appeared on November 17, 1935.

98. RAWALPINDI (1,674 ft. above sea level). YELLOW RUST. ORIGINAL MAP No. 300.

Date and height of trajectory in feet ...	February 15, 1934 : B—3280.
Dates of spore shower soon after the wind ...	No spores were caught.
Dates of spore shower 14—10 days before rust appearance	No spores were caught.
Date of rust appearance	March 1, 1934.

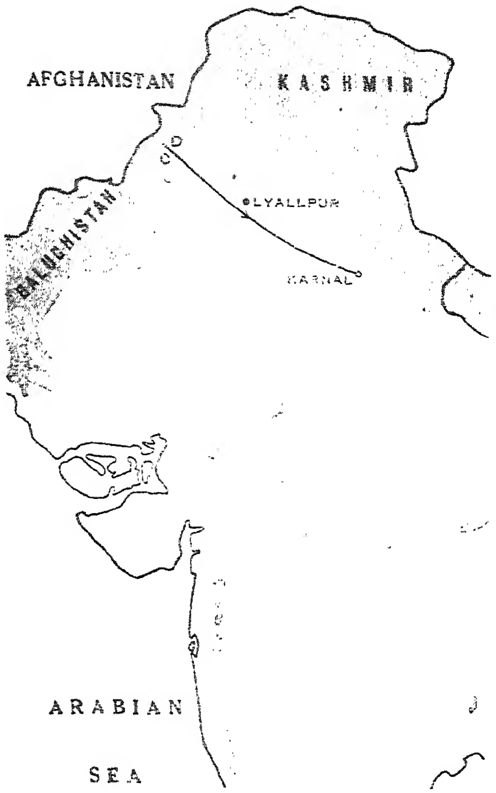
B –The wind was traceable from Simla hills and passed over Simla where yellow rust had appeared on November 20, 1933.

99 & 100. KARNAL (900 ft. above sea level). YELLOW RUST. ORIGINAL MAP Nos. 1,560 & 1,574.

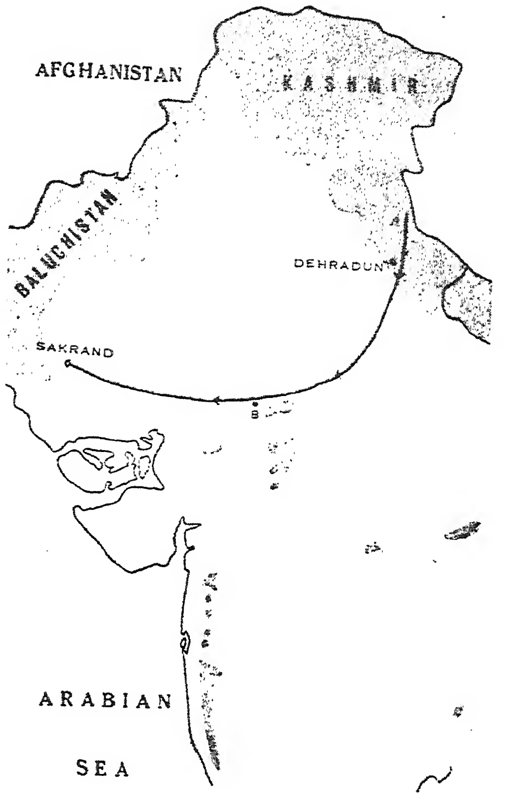
Dates and heights of trajectories in feet ...	December 23, 1936 & January 6, 1937 : A—1640. B—3280.
Dates of spore shower soon after the winds ...	No spores were caught.
Dates of spore shower 14—10 days before rust appearance	January 11—14.
Date of rust appearance	January 22, 1937.

A & B—The winds were traceable from Siwalik range and passed near Simla where yellow rust had appeared on November 17, 1936.

MAP NO. 101



MAP NO. 102



101. KARNAL (900 ft. above sea level). YELLOW RUST. ORIGINAL MAP No. 1,573.

Date and heights of trajectories in feet ...	January 5, 1937 : C—4920, D—6560.
Dates of spore shower soon after the winds ...	No spores were caught.
Dates of spore shower 14—10 days before rust appearance	January 11—14.
Date of rust appearance	January 22, 1937.

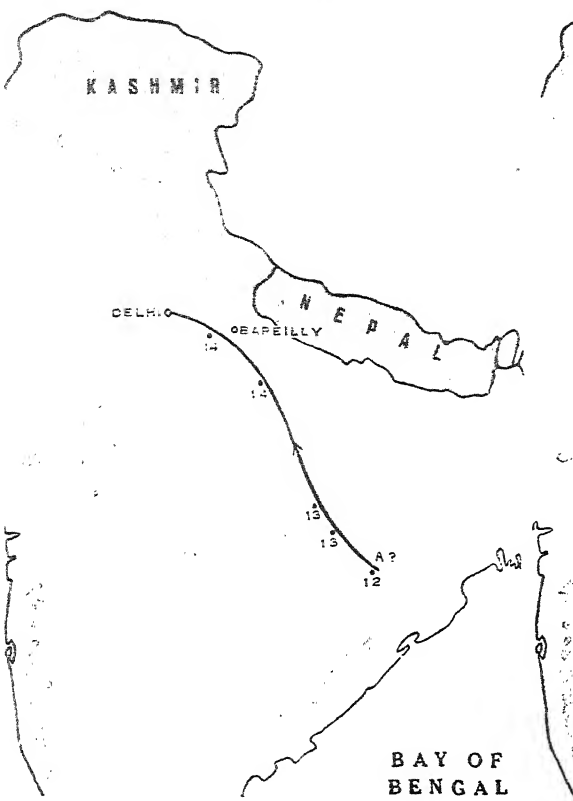
C & D—The winds were traceable from N.-W. F. Province and passed near Lyallpur where yellow rust had appeared on December 20, 1936.

102. SAKRAND (120 ft. above sea level). YELLOW RUST. ORIGINAL MAP No. 1,281.

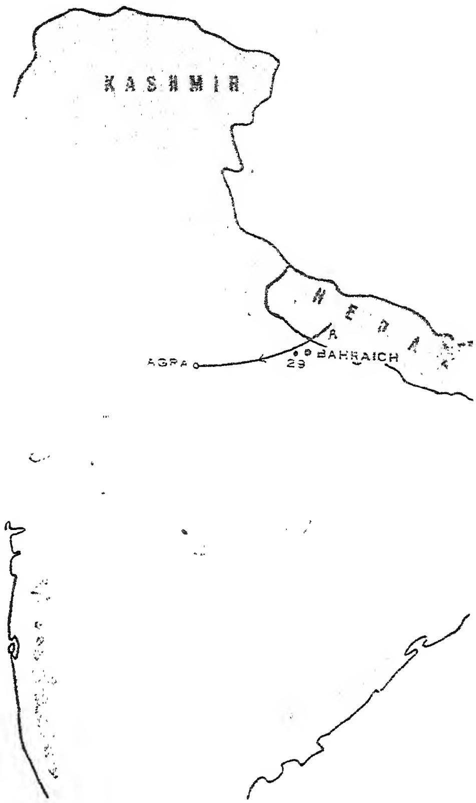
Date and height of trajectory in feet ...	February 9, 1936 : A—1640.
Dates of spore shower soon after the wind ...	No spores were caught.
Dates of spore shower 14—10 days before rust appearance	No spores were caught.
Date of rust appearance	February 28, 1936.

A—The wind was traceable from Siwalik range and passed near Dehradun where yellow rust had appeared on December 21, 1935.

MAP NO. 103



MAP NO. 104



103. DELHI (714 ft. above sea level). YELLOW RUST. ORIGINAL MAP No. 2,114.

Date and height of trajectory in feet ...	January 15, 1938 : A—1640.
Dates of spore shower soon after the wind ...	No spores were caught.
Dates of spore shower 14—10 days before rust appearance	No spores were caught.
Date of rust appearance	February 2, 1938.

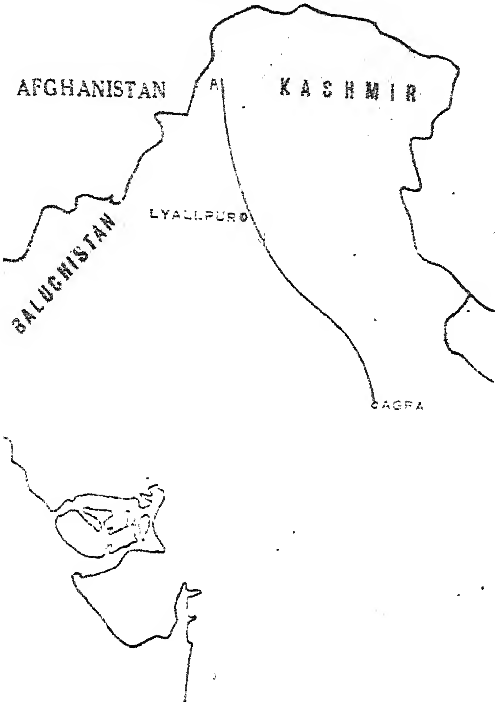
A—The wind was traceable from Orissa and passed near Bareilly where yellow rust was observed in traces on January 1—2, 1938.

104. AGRA (554 ft. above sea level). YELLOW RUST. ORIGINAL MAP No. 925.

Date and height of trajectory in feet ...	January 30, 1935 : A—1640.
Dates of spore shower soon after the wind ...	No spores were caught.
Dates of spore shower 14—10 days before rust appearance	No spores were caught.
Date of rust appearance	February 24, 1935.

A—The wind was traceable from central Nepal, where 20—25 per cent crop infection with yellow rust was observed on December 23—24, 1934 and passed near Bahraich where yellow rust had appeared on January 4, 1935.

MAP NO. 105



MAP NO. 106

105. AGRA (554 ft. above sea level). YELLOW RUST. ORIGINAL MAP No. 1,615.

Date and height of trajectory in feet ... January 16, 1937 : A—1640.

Dates of spore shower ... ... January 14—17.**

Dates of spore shower 14—10 days before rust appearance ... ... February 3—6.

Date of rust appearance ... ... February 15, 1937.

A—The wind was traceable from N.-W. F. Province and passed near Lyallpur where yellow rust had appeared on December 20, 1936.

**The spore shower might have occurred on January 14 or 15, due to some earlier wind.

106. AGRA (554 ft. above sea level). YELLOW RUST. ORIGINAL MAP No. 1,629.

Date and height of trajectory in feet ... January 30, 1937 : B—3280.

Dates of spore shower soon after the wind ... No spores were caught.

Dates of spore shower 14—10 days before rust appearance ... ... February 3—6.

Date of rust appearance ... ... February 15, 1937.

B—The wind was traceable from N.-W. F. Province and passed near Lyallpur where yellow rust had appeared on December 20, 1936.

MAP NO. 107

MAP NO.

107. AGRA (554 ft. above sea level). YELLOW RUST. ORIGINAL MAP No. 2,177.

Date and height of trajectory in feet ... February 2, 1938 : C—4920.

Dates of spore shower ... ... No spores were caught.

Dates of spore shower 14—10 days before rust appearance ... ... No spores were caught.

Date of rust appearance ... ... February 19, 1938.

C—The wind was traceable from U.P. hills and passed near Bareilly on February 1 where yellow rust had appeared on January 1—2, 1938.

108.

Date and height of trajectory in feet ... January 16, 1933 : D—6560.

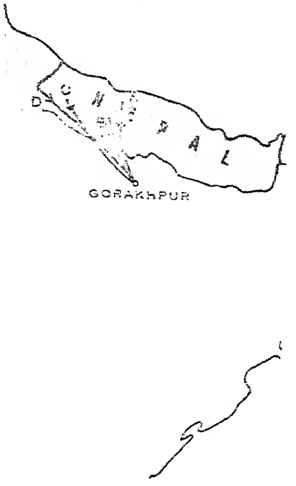
Dates of spore shower soon after the wind ... No spores were caught.

Dates of spore shower 14—10 days before rust appearance ... ... February 4—7.

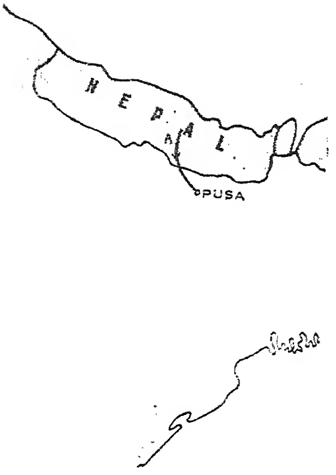
Date of rust appearance ... ... February 15, 1933.

D—The wind was traceable from Simla hills and passed near Simla where yellow rust had appeared on November 25, 1932.

MAP NO. 109



MAP NO. 110



MAP NO. 111

109. GORAKHPUR (257 ft. above sea level). YELLOW RUST. ORIGINAL MAP Nos. 820, 821, 822 & 823.

Date and heights of trajectories in feet ... January 4, 1935 : A—1640, B—3280, C—4920, D—6560.
Dates of spore shower soon after the winds ... No spores were caught.
Dates of spore shower 14—10 days before rust appearance ... ... No spores were caught.
Date of rust appearance ... ... January 28, 1935.
A & B—The winds were traceable from central Nepal where 20—25 per cent crop infection with yellow rust was observed on December 23—24, 1934.
C & D—The winds were traceable from western Nepal where yellow rust was observed in traces on November 30, 1934 and passed through central Nepal where 20—25 per cent crop infection was observed on December 23—24, 1934.

110. PUSA (188 ft. above sea level). YELLOW RUST. ORIGINAL MAP No. 1,005.

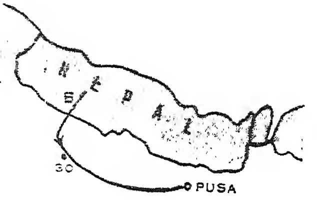
Date and height of trajectory in feet ... December 21, 1934 : A—1640.
Dates of spore shower soon after the wind ... No spores were caught.
Dates of spore shower 14—10 days before rust appearance ... ... No spores were caught.
Date of rust appearance ... ... January 7, 1935.
A—The wind was traceable from central Nepal where 20—25 per cent crop infection with yellow rust was observed on December 23—24, 1934.

111. PUSA (18 ft. above sea level). YELLOW RUST. ORIGINAL MAP No. 1,003.

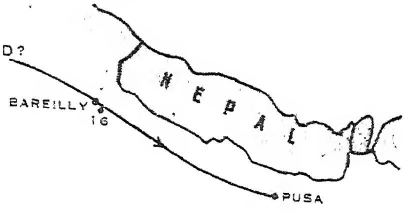
Date and heights of trajectories in feet ... December 19, 1934 : B—3280, C—4920, D—6560.
Dates of spore shower soon after the winds ... No spores were caught.
Dates of spore shower 14—10 days before rust appearance ... ... No spores were caught.
Date of rust appearance ... ... January 7, 1935.
B, C & D—The winds were traceable from central Nepal where 20—25 per cent crop infection with yellow rust was observed on December 23—24, 1934.

MAP NO. 112

MAP NO. 113



MAP NO. 114



112. PUSA (188 ft. above sea level). YELLOW RUST. ORIGINAL MAP No. 1,139.

Date and height of trajectory in feet ...	January 2, 1936 : A—1640.
Dates of spore shower soon after the wind ...	January 3—7.
Dates of spore shower 14—10 days before rust appearance	January 3—7.
Date of rust appearance	January 20, 1936.

A—The wind was traceable from central Nepal where 60 per cent crop infection with yellow rust was observed on December 28, 1935.

113. PUSA (188 ft. above sea level). YELLOW RUST. ORIGINAL MAP No. 1,382.

Date and height of trajectory in feet ...	December 31, 1935 : B—3280.
Dates of spore shower soon after the wind ...	January 3—7.
Dates of spore shower 14—10 days before rust appearance	January 3—7.
Date of rust appearance	January 20, 1936.

B—The wind was traceable from central Nepal where 60 per cent crop infection with yellow rust was observed on December 28, 1935.

114. PUSA (188 ft. above sea level). YELLOW RUST. ORIGINAL MAP No. 2,255.

Date and height of trajectory in feet ...	January 17, 1938 : D—6560.
Dates of spore shower soon after the wind ...	January 17—20.
Dates of spore shower 14—10 days before rust appearance	No spores were caught.
Date of rust appearance	February 7, 1938.

D—The wind was traceable from south eastern part of Punjab and passed over Bareilly where yellow rust was observed in traces on January 1—2, 1938.

MAP NO. 115

MAP NO. 116

115. SABOUR (122 ft. above sea level). YELLOW RUST. ORIGINAL MAP No. 772.

Date and height of trajectory in feet ... February 9, 1935 : A—1640.

Dates of spore shower soon after the wind ... No spores were caught.

Dates of spore showers 14—10 days before rust appearance ... ... February 18—21 & 21—25.

Date of rust appearance ... ... March 4, 1935.

A—The wind was traceable from central Nepal where 20—25 per cent crop infection with yellow rust was observed on December 23—24, 1934 and passed near Pusa where the rust had appeared on January 7, 1934.

116. SABOUR (122 ft. above sea level). YELLOW RUST. ORIGINAL MAP Nos. 784 & 785.

Date and heights of trajectories ... ... February 14, 1935 : B—3280, C—4920, D—6560.

Dates of spore shower soon after the winds ... February 18—21.

Dates of spore showers 14—10 days before rust appearance ... ... February 18—21 & 21—25.

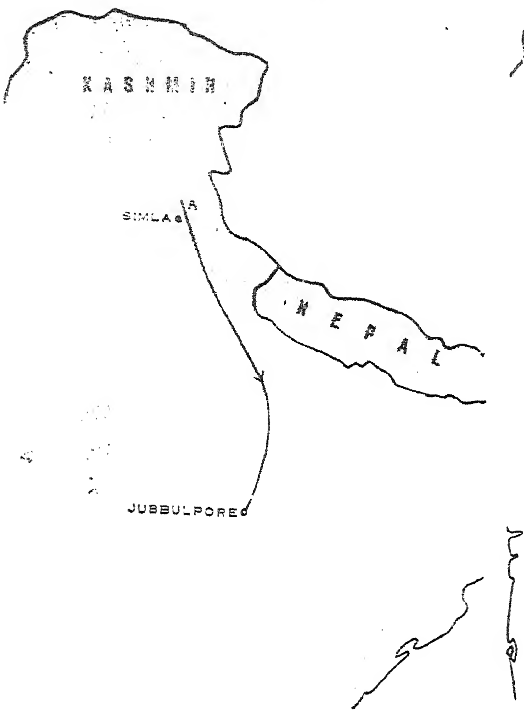
Date of rust appearance ... ... March 4, 1935.

B—The wind was traceable from western Nepal where yellow rust was found in traces on November 30, 1934 and passed through central Nepal where 20—25 per cent crop infection was observed on December 23—24, 1934, near Gonda where 2 per cent crop infection was observed on January 27 and near Pusa where the rust had appeared on January 7, 1934.

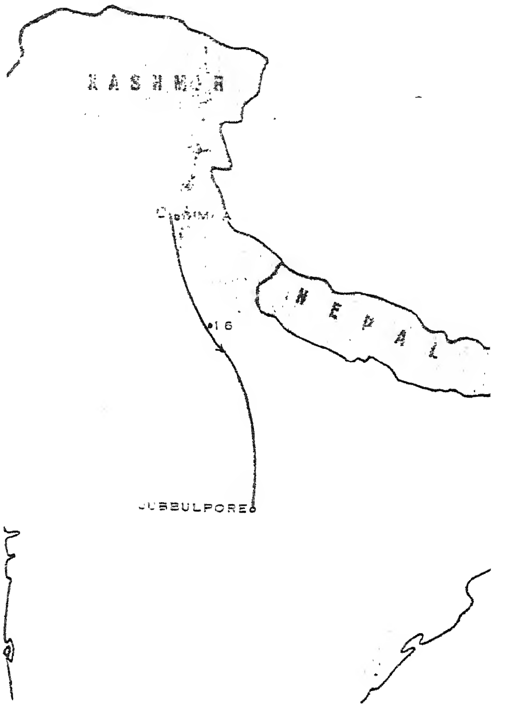
C—The wind was traceable from central Nepal where 20—25 per cent crop infection with yellow rust was observed on December 23—24, 1934 and passed near Gonda where 2 per cent crop infection was observed on January 27 and near Pusa where the rust had appeared on January 7, 1934.

D—The wind was traceable from central Nepal where 20—25 per cent crop infection with this rust was observed on December 23—24, 1934.

MAP NO. 117



MAP NO. 118



117. JUBBULPORE (1,289 ft. above sea level). YELLOW RUST. ORIGINAL MAP No. 1,830.

Date and height of trajectory in feet ...	January 13, 1937 : A—1640.
Dates of spore showers soon after the wind ...	January 13—16 & 16—20.
Dates of spore shower 14—10 days before rust appearance	January 30—February 3.
Date of rust appearance	March 3, 1937 (Traces—20 per cent crop infection on February 24, 1937).

A—The wind was traceable from Siwalik range and passed near Simla where yellow rust had appeared on November 17, 1936.

118. JUBBULPORE (1,289 ft. above sea level). YELLOW RUST. ORIGINAL MAP No. 1,834.

Date and heights of trajectories in feet ...	January 17, 1937 : B—3280, C—4920.
Dates of spore showers	January 16—20,** 20—23 & 23—27.
Dates of spore shower 14—10 days before rust appearance	January 30—February 3.
Date of rust appearance	March 3, 1937 (Traces—20 per cent crop infection on February 24, 1937).

B & C—The winds were traceable from Simla hills and passed over Simla where yellow rust had appeared on November 17, 1936.

**The spore shower might have occurred on January 16, due to some earlier wind.

MAP NO. 119

MAP NO. 120

119. LYALLPUR (605 ft. above sea level). YELLOW RUST. ORIGINAL MAP Nos. 776 & 777

Date and heights of trajectories in feet ... February 10, 1935 : A—1640, B—3280, C—4920, D—6560.

Dates of spore shower soon after the winds ... February 11—14.

Dates of spore shower 14—10 days before rust appearance ... ... No spores were caught.

Date of rust appearance ... ... March 1st week.

A—The wind was untraceable.

B—Traceable from Afghanistan and passed over Peshawar.

C—Traceable from N.-W. F. Province and passed over Murree and Rawalpindi.

D—Traceable from N.-W. F. Province.

120. LYALLPUR (605 ft. above sea level). YELLOW RUST. ORIGINAL MAP Nos. 1,155 & 1,156.

Date and heights of trajectories in feet ... January 10, 1936 : A—1640, B—3280, C—4920, D—6560.

Dates of spore shower soon after the winds ... January 10—14.

Dates of spore shower 14—10 days before rust appearance ... ... January 10—14.

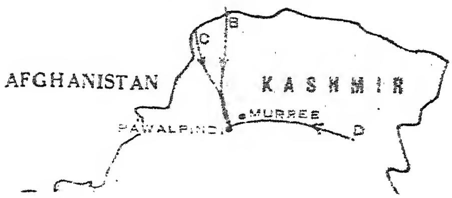
Date of rust appearance ... ... January 27, 1936.

A—Traceable from Afghanistan.

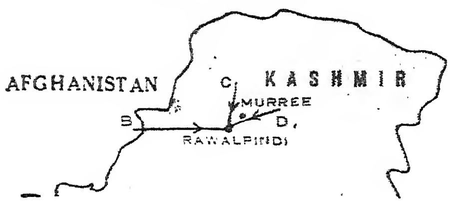
B & D—Traceable from N.-W. F. Province.

C—Traceable from Suleiman range.

MAP NO. 121



MAP NO. 122



MAP NO. 123

121. RAWALPINDI (1,674 ft. above sea level). YELLOW RUST. ORIGINAL MAP Nos. 914, 915 & 916.

Date and heights of trajectories in feet ... January 27, 1935 : B—3280, C—4920, D—6560.

Dates of spore shower soon after the winds ... January 28—February 1.

Dates of spore shower 14—10 days before rust appearance ... ... No spores were caught.

Date of rust appearance ... ... February 4th week.

B & C—Traceable from N.-W. F. Province

D—Traceable from Kashmir and passed near Murree.

122. RAWALPINDI (1,674 ft. above sea level). YELLOW RUST. ORIGINAL MAP Nos. 1,219 & 1,220.

Date and heights of trajectories in feet ... January 20, 1936 : B—3280, C—4920, D—6560.

Dates of spore shower soon after the winds ... January 21—24.

Dates of spore shower 14—10 days before rust appearance ... ... January 31—February 3.

Date of rust appearance ... ... February 10, 1936.

B & C—Traceable from N.-W. F. Province. Wind C passed near Murree as well.

D—Traceable from Kashmir and passed over Murree.

123. AGRA (554 ft. above sea level). YELLOW RUST. ORIGINAL MAP No. 1,303.

Date and heights of trajectories in feet ... December 16, 1935 : A—1640, B—3280, C—4920, D—6560.

Dates of spore shower soon after the winds ... December 17—19.

Dates of spore shower 14—10 days before rust appearance ... ... No spores were caught.

Date of rust appearance ... ... January 15, 1936.

A—Traceable from N.-W. F. Province and passed near Lyallpur and Delhi.

B—Traceable from Baluchistan and passed near Khanewal.

C—Traceable from Suleiman range and passed near Bikaner.

D—Traceable from Baluchistan and passed near Quetta and Bikaner.

Yellow rust appeared at Lyallpur on January 27 and at Khanewal on February 17. At Delhi 20 per cent crop infection with this rust was observed on February 22, 1936.

(*a*) *Lyallpur, 605 feet above sea level (Punjab).* In four years out of six for which wind-trajectories were studied no spore showers were found 4 to 2 weeks before rust appearance.

In 1934-35 rust appeared at Lyallpur in the first week of March and a spore shower took place on February 11 to 14. Trajectories were studied for February 1 to 14 but none of the winds passed over a station of known earlier appearance of rust. Some winds came from Afghanistan but they could not be considered as 'relevant' because rust appeared much later at the intermediate stations. Two winds from Kashmir and one from Murree hills, however, might be regarded as 'possibly relevant' on account of oversummering in those areas. Winds of February 10 are reproduced on Map No. 119.

In 1935-36 rust appeared on January 27 and spore showers occurred on January 7 to 10 and 10 to 14. Trajectories were studied for December 27 to January 12 but none of the winds had passed over a station of known earlier appearance of rust. Several winds came from the N.-W. F. Province and some passed over Peshawar and Rawalpindi, where rust appeared in the first week of February and February 10 respectively. One of the winds came from Kashmir which may, for reasons given before, be considered as 'possibly relevant'. Winds of January 10 are reproduced on Map No. 120.

(*b*) *Rawalpindi, 1,674 feet above sea level (Punjab).* For this station no 'relevant' winds were found during four years out of five but spore showers took place 4 to 2 weeks before rust appearance during two of them.

In 1934-35 rust broke out at Rawalpindi in the 4th week of February and a spore shower occurred on January 28 to February 1. Trajectories were studied for January 21 to February 9 but none of the winds was found to be 'relevant'. Seventeen winds came from eastern Kashmir, Murree and the Siwalik range which may, therefore, be regarded as 'possibly relevant'. Winds of January 27 are reproduced on Map No. 121.

In 1935-36 rust appeared on February 10 and a spore shower occurred on January 21 to 24. Trajectories were studied for January 10 to 24 but no wind was found to be 'relevant'. On January 14 and 20 there were three winds from Kashmir and Murree, which as already explained, may be regarded as 'possibly relevant'. Winds of January 20 are reproduced on Map No. 122.

Rawalpindi is situated in the foot-hills and inoculum might, therefore, have come down to this station with katabatic winds from Murree or even Kashmir.

(*c*) *Agra, 554 feet above sea level (United Provinces).* For this station no 'relevant' wind was found during 1935-36. Rust appeared on January 15 and spores were caught on December 17 to 19. Trajectories were studied for December 15 to 29. Some of the winds came from N.-W. F. Province and passed over Peshawar and Lyallpur, where rust appeared on the first week of February and on January 27 respectively. A few winds also came from Baluchistan and passed over Khanewal, where rust appeared on February 17. Two winds on December 24 and 26 came from the Kumaon-hills and passed over Dehra Dun, where rust broke out on December 21, and could not for that reason be considered as 'relevant'. However, there were six 'possibly relevant' winds that year. Winds of December 16 are reproduced on Map No. 123.

The summary of data supplied in Map Nos. 119 to 123 is given in Table XXIV.

It is not possible to explain fully some of the misfits, i.e. rust outbreaks without spore showers and the absence of 'relevant' winds in cases where spore showers occurred. It is likely that inoculum may have come with 'possibly relevant' winds that blew during the intervals between daily meteorological observations. The inoculum may also have come from places of earlier outbreaks, wherefrom no information was available regarding the dates of rust appearance. Spore showers, if any, following such winds as were traced back to the hills in the Working Charts of the Meteorological Department and therefore interpreted as 'possibly relevant', are shown in Table XXII.

Stations of earlier rust appearance in the plains

Observations on the incidence of this rust were made at a large number of stations in addition to those where slides were exposed in aeroscopes. Information regarding the earliest and usual dates of rust appearance at representative stations including those in the foot-hills is given in Table XXV. It is clear from the Table that, like the other two, this rust appears, in general, much earlier in the foot-hills than in the neighbouring plains.

(*a*) *Early outbreaks due to nearness to hills.* The observations made in Part Two apply to this rust also as far as the Indo-Gangetic plain is concerned. As it thrives better at comparatively low temperatures than the other two, this rust breaks out earlier at higher altitudes in the hills, and as far as the foot-hills of the Punjab are concerned appears well in advance of black and brown rusts; this has already been explained in Part Two.

(*b*) *Early outbreaks due to early crops in the plains.* There are no early crops in the Indo-Gangetic plain. In the plains of Peninsular India, however, wheat is sown early in some of the districts but as explained before, this rust does not appear owing to unfavourable weather. It has not been found even in the miniature plots at Mandya and Coimbatore, both situated in the foot-hills.

(*iv*) *Winds in relation to initial rust outbreaks*

For this rust there was at least one 'relevant' or 'possibly relevant' wind for every station under study, as will be clear from the Table given below. Spore showers occurred soon after the 'relevant' or 'possibly relevant' winds in 18 out of 51 records of rust appearance. Spore showers also occurred prior to eight records of rust appearance but they could not be attributed to any 'relevant' or 'possibly relevant' wind. In all these cases spores were caught nearly 4 to 2 weeks before rust appearance. No information could be obtained regarding spore showers at two stations as no slides were exposed. Of the remaining 23 records, spores were caught only 14 to 10 days or so

During 938-39 there was no relevant' wind for Lyallpur and Rawalpindi but five such winds were found for Agra. The number of 'possibly relevant' winds for these stations was 14, 6 and 24 respectively.

In 1939-40 there was only one 'relevant' wind for Agra and none for the other two stations. That year there were six 'possibly relevant' winds for Layallpur, nine for Rawalpindi and six for Agra.

Full information regarding the dissemination of this rust to representative stations during 1938-40 will be supplied in a later article.

before rust appearance in five and no spores were detected in others. A general summary of data regarding spore showers in relation to winds and records of rust appearance is given in Part Five, General Discussion and Conclusions.

Year	Number of stations for which trajectories were studied	Number of stations for which there was at least one 'relevant' or 'possibly relevant' wind		Number of stations for which there was no 'relevant' or 'possibly relevant wind
		Relevant	Possibly relevant only	
1932-33	4	3	1	0
1933-34	8	7	1	0
1934-35	10	7	3	0
1935-36	9	4	5	0
1936-37	10	6	4	0
1937-38	10	5	5	0

(*v*) *Probable foci of infection*

During these studies yellow rust has been found to break out, as a result of oversummering, at several places in the hills of the Punjab and United Provinces as early as November on the new crop sown in October and within a few yards of rusted self-sown wheat. In the Simla hills this rust broke out on the new crop at Kotkhai on October 31, 1933. On several occasions it has been observed in the latter half of November in the neighbourhood of Simla (7,000 ft. above sea level) as well as at Muktesar (nearly 7,500 ft. above sea level) in the Kumaon hills. At Chitrara, near Dalhousie (nearly 7,000 ft. above (sea level in the Siwalik range), it was found on November 7, 1936 and at Manali 6,500 ft. above sea level, Kulu Valley) 100 per cent infection of the new crop was observed in the third week of November, the same year.

In central Nepal (nearly 5,000 ft. above sea level) yellow rust showed nearly 60 per cent infection on the October crop in the last week of December 1935. Here in all probability the inoculum came from higher altitudes as this rust is normally unable to oversummer below altitudes of nearly 6,000 ft. and no rusted self-sown plants were found at the time of observation.

At higher altitudes in the Nilgiris and Palni hills, this rust is found in abundance by August-September on the first crop. From spore showers at several stations in the plains of Peninsular India, as recorded in Table XVIII, it is clear that this rust is disseminated to those places but is unable to establish itself owing to unfavourable weather.

This rust is able to oversummer only at altitudes of nearly 6,000 ft. and above and thrives best at comparatively low temperatures. Its oversummering in the uredostage in the hills has been fully established. Consequently, there are several foci of infection in the Himalayan range, including the higher altitudes of Nepal. The foci in the south, i.e. the Nilgiris and Palni hills, seem to be ineffective because of unfavourable weather in the plains of Peninsular India.

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TABLE XVII

Si 'y o aeroscope-slide **yellow rus**

Year	Period of exposure	Dates of first spore shower. Number of spores in brackets	Dates of spore shower, if any, 4 to 2 weeks before rust appearance. Number of spores in brackets	Date of rust appearance, as reported from the station	Date of observation,* if any, regarding incidence of rust
			PUNJAB		
			1. Lyallpur		
1929-30	January 4—March 30 ...	March 5—8 (6)	No spores	January 2nd week	
1930-31	January 10—April 10 ...	January 17—21 (1)	January 17—21 (1)	February 9	
1931-32	November 21—April 5 ...	January 9—13 (1)	No spores ...	January 22	
1932-33	November 27—April 4 ...	January 7—11 (2)	No spores	February 20	
1933-34	November 1—March 24 ...	January 27—31 (1)	No spores ...	December 31	
1934-35	November 1—April 1 ...	January 31—February 4 (1)	February 11—14 (1)	March 1st week ...	March 22 (traces)
1935-36	November 2—April 7 ...	January 7—10 (1)	January 7—10 (1) January 10—14 (1)	January 27	
1936-37	December 3—April 15 ...	December 7—10 (1)	No spores (December 7—10)(*) (1)	December 20 ...	January 20 (traces—5 per cent)
1937-38	December 1—March 31 ...	February 14—17 (4)	No spores	January 17	

* Observations were made by members of the Rust Research Staff or occasionally the writer. The range of crop infection, wherever quoted, refers to different fields and on different varieties at that station

(*) Spore shower 13 to 10 days only before rust appearance

TABLE XV

Year	Period of exposure	Dates of first spore shower. Number of spores in brackets	Dates of spore shower, if any, 4 to 2 weeks before rust appearance. Number of spores in brackets	Date of rust appearance, as reported from the station	Date of observation if any, regarding incidence of rust
			2. Gurdaspur		
1931-32	November 15—March 15	December 24—27 (5)	December 24—27 (5)	January 15	
1932-33	December 2—February 5	December 13—17 (2)	No spores (January 16-19) (**) (1)	January 27	March 21 (10-15 per cent)
1933-34	November 3—February 26	December 8—12 (1)	December 8—12 (1)	December 27	
1934-35	November 1—April 1 ...	December 29—January 1(1)	December29—January 1 (1)	January 14	
1935-36	November 1—April 2 ...	January 10—13 (1)	No spores ...	January 4	
1936-37	No ember 20—April 14 ...	February 27—March 1 (3)	No spores	January 16	February 9 (2-5 per cent)
1937-38	December 1—April 13 ...	February 12—17 (1)	No spores	January 20	March 5 (3-50 per cent)
			3. Rupar		
1931-32	November 25—March 4 ...	December 30—January 2(1)	December 30—January 2(1)	January 15	
1932-33	January 1—10 ...	No spores	...	No information	
1933-34	January 17—February 1 ...	January 29—February 1 ... (Above 300)	† ...	January 16	
1935-36	November 15—March 27	January 10—14 (1)	...	No information	
1936-37	November 20—March 26	January 12—15 (1)	...	No rust	
1937-38	December 6—March 11 ...	January 17—21 (1)	...	No information	

(**) Spore shower 11 to 8 days only before rust appearance
† Slides were not exposed before January 17

TABLE XV (*con*

Year	Period of exposure	Dates of first spore shower Number of spores in brackets	Dates of spore shower, if any, 4 to 2 weeks before rust appearance. Number of spores in brackets	Date of rust appearance, as reported from the station	Date of observation, if any, regarding incidence of rust
			4. Hoshiarpur		
1931-32	November 17—March 16	February 9—12 (26)	No spores	January 15	
1932-33	January 14—April 3 ...	February 28—March 4 (1)	February 28—March 4 (1)	No information ...	March 22 (20 per cent)
1933-34	November 1—February 6	January 15—19 (1)	No spores	January 1st week	
1934-35	November 5—March 26 ...	No spores	No spores	February 1st half ...	March 18 (40-50 per cent)
1935-36	November 1—April 8 ...	January 1—5 (1)	No spores (January 1—5) (*)$_1$ (1)	January 1st half ...	January 25 (2 per cent)
1936-37	November 18—April 4 ...	December 9—12 (1)	December 9—12 (1)	January 5 ...	February 17 (2-15 per cent)
1937-38	December 1—March 31 ...	January 1—February 4 (1)	January 31—February 4 (1)	February 22 ...	March 13 (5-15 per cent)
			5. Rawalpindi		
1932-33	September 15—March 26	March 2—5 (1)	No spores (March 2—5) (*)$_2$ (1)	March 15	April 3rd week (20 per cent)
1933-34	January 21—April 18 ...	February 22—25 (4)	No spores	March 1	
1934-35	November 23—April 1 ...	January 28—February 1 (1)	January 28—February 1 (1)	February 4th week ...	March 24 (20-60 per cent)
1935-36	November 8—April 3 ...	January 13—21 (1)	January 21—24 (1)	February 10	
1936-37	January 1—April 20 ...	February 7—10 (4)	No spores ...	January 19	February 11 (2-12 per cent)
1937-38	December 15—April 25 ...	January 21—24 (1)	No spores	February 24 ...	February 24 (traces—3 per cent)

(*)$_1$ Spore shower nearly 14 to 10 days only before rust appearance
(*)$_2$ Spore shower 13 to 10 days only before rust appearance

TABI XV on

Year	Period of exposure	Dates of first spore shower. Number of spores in brackets	Dates of spore shower, if any, 4 to 2 weeks before rust appearance. Number of spores in brackets	Date of rust appearance, as reported from the station	Date of observation, if any, regarding incidence of rust
			6. Simla* 7,000 feet above sea level		
1932-33	September 15—April 6 ...	September 18—21 (2)	October 31—November 3(5)	November 25	
1933-34	November 1—February 24	November 1—4 (25)	November 1—4 (25)	November 20	
1934-35	July 2—April 24 ...	July 8—11 (4)	November 24—28 (25)	December 16	
1935-36	November 1—April 4 ...	November 16—20 (5)	December 4—7 (3)	December 21	
1936-37	October 3—April 14 ...	October 3—7 (24)	October 28—31 (4)	November 17	
1937-38	November 1—May 23 ...	December 6—9 (2)	January 3—6 (2)	January 21	
			7. Khanewal		
1933-34	December 3—March 7 ...	December 17—20 (1)	December 17—20 (1)	January 12	
1934-35	November 1—April 2 ...	February 10—13 (3)	February 20—24 (9)	March 7	March 23 (traces)
1935-36	November 7—April 5 ...	January 12—15 (1)	January 29—February 1 (1)	February 17 ...	March 19 (3-4 per cent)
1936-37	January 1—April 7 ...	January 30—February 3 (1)	February 3—6 (4)	February 20	
1937-38	December 4—April 3 ...	February 5—8 (1)	[No spores (February 5—8) (*) (1)]	February 18	

* Observations for rust appearance at Simla were made by members of the Rust Research Staff. Rust is able to oversummer at that locality because of favourable weather

(*) Spore shower 13 to 10 days only before rust appearance

TAB XV *contd*

Year	Period of exposure	Dates of first spore shower. Number of spores in brackets	Dates of spore shower, if any, 4 to 2 weeks before rust appearance. Number of spores in brackets	Date of rust appearance, as reported from the station	Date of observation, if any, regarding incidence of rust
			8. Karnal		
1933-34	October 15—March 3 ...	October 15—18 (1)	No spores	January 14	
1934-35	October 15—March 14 ...	February 7—11 (1)	No spores (February 7—11)(**) (1)	February 20 ...	March 16 (traces)
1935-36	October 15—March 16 ...	November 14—18 (3)	December 16—19 (1)	January 7	March 20 (Teleuto stage)
1936-37	December 17—March 25 ...	December 21—24 (1)	January 4—7 (1)	January 22	
1937-38	December 2—April 7 ...	February 3—7 (6)	No spores ...	January 16	
			BALUCHISTAN		
			9. Quetta		
1932-33	September 15—May 8 ...	February 24—28 (3)	...	No information	
1933-34	March 23—April 12 ...	No spores	...	No information	
1935-36	November 5—December 16	No spores	...	No information	
1936-37	November 21—April 24 ...	April 13—17 (5)	...	No rust	
1937-38	January 15—May 23 ...	No spores	No spores	May 18	

9 days only b

XV

Year	Period of exposure	Dates of first spore shower. Number of spores in brackets	Dates of spore shower, if any, 4 to 2 weeks before rust appearance. Number of spores in brackets	Date of rust appearance, as reported from the station	Date of observation, if any, regarding incidence of rust
		N.-W. F. PROVINCE			
		10. Peshawar (Tarnab farm)			
1935-36	November 15—April 6 ...	No spores	No spores	February 1st week	
1936-37	December 28—February 12	No spores	No spores	February 23	
1937-38	November 28—March 1 ...	January 16—20 (1)	January 16—20 (1)	February 18	
		SIND			
		11. Karachi			
1932-33	September 8—December 22	No spores	...	No information	
		12. Sakrand			
1932-33	September 15—March 17	No spores	...	No information	
1933-34	December 11—March 15	March 4—6 (1)	...	No information	
1934-35	November 5—April 4 ...	January 31—February 3 (2)	February 3—6 (4)	February 26 ...	March 7 (5-50 per cent)
1935-36	November 5—April 1 ...	No spores	No spores	February 28	
1936-37	December 3—March 25 ...	March 13—16 (2)	No spores	March 13	
1937-38	November 27—March 15	No spores	...	No information	

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Year	Period of exposure	Dates of first spore shower. Number of spores in brackets	Dates of spore shower, if any, 4 to 2 weeks before rust appearance. Number of spores in brackets	Date of rust appearance, as reported from the station	Date of observation, if any regarding incidence of rust
			DELHI		
			13. Delhi (Imperial Agricultural Research Institute)		
1936-37	November 17—March 15	January 26—29 (2)	No Spores (January 26—29)(*)$_1$ (2)	February 8 ...	February 27 (10-40 per cent)
1937-38	December 1—April 2 ...	February 12—16 (11)	No spores	February 2 ...	March 20—21 (0-100 per cent)
			UNITED PROVINCES		
			14. Agra* (Bichpuri farm)		
1929-30	January 4—March 1 ...	January 25—29 (2)	No spores	January 29	
1930-31	December 31—February 21	January 21—24 (2)	No spores	January 3	
1931-32	November 28—March 15	January 30—February 3 (1)	No spores (January 30—February 3 (*)$_2$ (1)	February 2nd week	
1932-33	December 17—March 10	February 4—7 (1)	No spores (February 4—7) (*)$_3$ (1)	February 15	

(*)$_1$ Spore shower 13 to 10 days only before rust appearance
* Observations for rust appearance at Agra were made by the writer or members of the Rust Research Staff
(*)$_2$ Spore shower might have occurred only 10 to 8 days before rust appearance
(*)$_3$ Spore shower 11 to 8 days only before rust appearance

X

Year	Period of exposure	Dates of first spore shower. Number of spores in brackets	Dates of spore shower, if any, 4 to 2 weeks before rust appearance. Number of spores in brackets	Date of rust appearance, as reported from the station	Date of observation, if any, regarding incidence of rust
1933-34	November 1—February 7	January 21—24 (5)	No spores / (January 21—24) $(*)_4$ (5)	February 2	
1934-35	October 16—March 10 ...	No spores	No spores	February 24	
1935-36	October 18—February 1	December 14—16 (1)	December 17—19 (4)	January 15	
1936-37	November 17—February 15	January 14—17 (2)	January 14—17 (2)	February 15	
1937-38	November 20—March 13	January 3—6 (2)	January 30—February 3 (2)	February 19	
			15. Gorakhpur		
1930-31	December 1—January 25	December 26—31 (1)	No spores	December 31	
1931-32	December 14—March 4 ...	December 18—26 (1)	No spores ...	January 1st week	
1932-33	September 27—February 7	November 14—19 (1)	December 6—12 (1)	January 10	
1933-34	October 15—January 18 ...	December 13—16 (2)	December 13—16 (2)	February 1st and 2nd week†	January 15 (traces)
1934-35	October 15—March 7 ...	November 30—December 2 (1)	No spores	January 28	January 28 (traces)
1935-36	October 15—March 21 ...	November 11—14 (1)	December 23—26 ...	January 26	January 26 (1-10 per cent)
1936-37	November 3—January 22	November 26—28 (1)	...	No information	
1937-38	November 15—March 15	December 9—31 (2)	January 3—6 (1)	January 27	

$(*)_4$ Spore shower 12 to 9 days only before rust appearance

† The information received stated Rusts were found in the 1st and 2nd week of February. No rust was specified

TABLE X

Year	Period of exposure	Dates of first spore shower. Number of spores in brackets	Dates of spore shower, if any, 4 to 2 weeks before rust appearance. Number of spores in brackets	Date of rust appearance, as reported from the station	Date of observation, if any, regarding incidence of rust
			16. Allahabad (Naini farm)		
1929-30	December 16—March 3 ...	No spores	No spores	No information ...	February 4 (traces)
1936-37	December 3—March 6 ...	December 3—8 (1)	December 31—January 4(2)	February 2	February 20 (traces—10 per cent)
1937-38	November 16—March 16	December 29—January 2 (1)	January 2—6 (1)	January 30 ...	March 10 (0-10 per cent)
			17. Cawnpore		
1930-31	January 17—March 10 ...	January 28—31 (2)	No spores (January 28—31) (*)$_1$ (2)	February 2nd week	
1931-32	November 15—February 7	February 4—7 (6)	...	No information	
1932-33	December 1—March 2 ...	January 19—23 (1)	No spores (January 19—23) (*)$_2$ (1)	February 1st week*	
1933-34	October 15—January 14 ... February 2—March 1	February 2—5 (4)	No spores	No information ...	March 10 (in teleuto stage)
1934-35	October 19—March 11 ...	No spores	No spores	No rust	February 19 (traces)
1935-36	October 18—March 9 ...	December 20—23 (3)	...	No information	
1936-37	January 1—March 15 ...	February 1—5 (1)	February 5—8 (2)	No information ...	February 25 (1-10 per cent)
1937-38	January 13—March 18 ...	February 4—7 (1)	February 7—9 (3) February 12—15 (15)	March 1st week ...	March 11 (20-70 per cent)

(*)$_1$ Spore shower nearly 14 to 10 days only before rust appearance
(*)$_2$ Spore shower nearly 14 to 10 days only before rust appearance
* The information received stated Rusts appeared in the 1st week of February. No rust was specified

AB XV

Year	Period of exposure	Dates of first spore shower. Number of spores in brackets	Dates of spore shower, if any, 4 to 2 weeks before rust appearance. Number of spores in brackets	Date of rust appearance, as reported from the station	Date of observation, if any, regarding incidence of rust
			18. Bareilly (Nawabganj	**farm)**	
1932-33	September 15—March 14	January 17—21 (35)	January 17—21 (35)	February 1st week	
1933-34	October 22—February 28	December 13—17 (2)	December 13—17 (2)	January 11	January 7 (traces)
1934-35	October 15—March 12 ...	No spores	No spores	January 30	January 19 (5-10 per cent)
1935-36	October 15—March 9 ...	January 4—6 (5)	{No spores (January 4—6)(*)$_3$ (5)}	January 15	
1936-37	November 15—March 20	December 20—22 (1)	January 10—12 (3)	January 24	
1937-38	November 15—March 15	December 14—17 (1)	December 14—17 (1)	January 29	January 1—2 (traces)
			19. Shahjahanpur		
1932-33	September 15—February 21	February 9—12 (1)	...	No rust	
1933-34	October 15—February 4	January 21—24 (1)	No spores	February 1st week ...	February 1—2 (20 per cent)
1934-35	October 15—March 9 ...	January 25—29 (1)	...	No information	
1935-36	October 15—March 22 ...	January 10—14 (5)	January 21—25 (2)	No information ...	February 7 (traces)
1936-37	November 1—April 7 ...	January 19—23 (1)	...	No rust	
1937-38	November 15—March 21	January 24—28 (5)	January 31—February 4(7)	February 20	
			20. Almora		
1932-33	October 26—March 2 ...	October 29—November 2(3)	December 7—10 (12)	December 25	

(*)$_3$ Spore shower 11 to 9 days only before rust appearance

XV

Year	Period of exposure	Dates of first spore shower. Number of spores in brackets	Dates of spore shower, if any, 4 to 2 weeks before rust appearance. Number of spores in brackets	Date of rust appearance, as reported from the station	Date of observation, if any, regarding incidence of rust
			21. Tarikhet		
1933-34	October 20—March 15 ...	October 23—26 (4)	February 18—21 (15)	March 10 ...	March 25—26 (30-70 per cent)
1934-35	October 15—March 26 ...	February 21—24 (1)	No spores	March 1	
1935-36	October 15—March 13 ...	December 3—6 (1)	...	No information	
1936-37	January 25—April 18 ...	January 25—28 (1)	...	No information	
1937-38	November 15—March 18	December 30—January 2 (30)	...	No information	
			22. Jhansi (Bharari farm)		
1933-34	February 18—March 18 ...	February 18—21 (8)	†	No rust	Collected on March 5 (Mostly in teleuto stage)
1934-35	October 15—March 23 ...	January 18—21 (1)	...	No information	
1935-36	November 8—March 30 ...	January 14—17 (1)	January 14—17 (1)	February 15	
1936-37	November 11—February 8	December 21—25 (1)	January 22—25 (2) February 5—8 (1)	No rust	February 21 (traces)
1937-38	November 15—March 21	January 4—6 (1)	February 1—3 (31)	February 20	

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TAB X con

Year	Period of exposure	Dates of first spore shower. Number of spores in brackets	Dates of spore shower, if any, 4 to 2 weeks before rust appearance. Number of spores in brackets	Date of rust appearance, as reported from the station	Date of observation, if any, regarding incidence of rust
			23. Benares		
1933-34	October 22—February 14	December 31—January 3 (1)	January 28—31 (22)	No information ...	March 19 (In teleuto stage)
1934-35	October 15—March 15 ...	February 7—10 (9)	No spores (February 7—10) (*) (9)	February 17 ...	February 21 (traces)
1935-36	October 20—March 20 ...	January 7—10 (1)	No spores (January 7—10) (**) (1)	January 19	
1936-37	November 1—March 17 ...	December 19—22 (1)	No spores	No information ...	February 18 (traces—7 per cent)
1937-38	November 20—March 26	January 25—28 (25)	No spores	February 5	January 30 (traces)
			24. Fyzabad		
1934-35	November 15—March 13	No spores	No spores	Middle of January ...	March 6 (In teleuto stage)
1935-36	October 15—January 29 ...	January 8—11 (57)	No spores	January 14	February 17 (1-60 per cent)
1936-37	November 1—February 25	November 22—25 (1)	No spores	No information ...	February 21 (traces—20 per cent)
1937-38	November 21—March 17	No spores	...	No information	

XV—*co*

Year	Period of exposure	Dates of first spore shower. Number of spores in brackets	Dates of spore shower, if any, 4 to 2 weeks before rust appearance. Number of spores in brackets	Date of rust appearance, as reported from the station	Date of observation, if any, regarding incidence of rust
			25. Dehradun		
1935-36	October 15—March 20 ...	January 27—30 (2)	No spores	December 21 ...	February 21 (40-60 per cent)
1936-37	November 2—March 16 ...	January 4—7 (1)	No spores	January 1st week ...	February 23 (10-65 per cent)
1937-38	November 15—March 18	January 21—25 (1)	February 15—18 (1)	March 5	
			BIHAR		
			26. Pusa		
1931-32	November 15—March 2 ...	December 20—24 (1)	December 20—24 (1)	January 16	
1932-33	September 15—March 19	November 3—7 (4)	No spores	February 3	
1933-34	October 16—February 8 ...	November 23—27 (2)	January 1—4 (3)	January 19	
1934-35	October 15—March 11 ...	December 31—January 3 (1)	No spores	January 7	
1935-36	October 15—March 20 ...	January 3—7 (1)	January 3—7 (1)	January 20	
1936-37	November 20—April 30 ...	No spores	No spores	February 3 ...	January 30—31 (0-15 per cent)
1937-38	November 15—March 21	January 17—20 (1)	January 17—20 (1)	February 7	

TABL

Year	Period of exposure	Dates of first spore shower. Number of spores in brackets	Dates of spore shower, if any, 4 to 2 weeks before rust appearance. Number of spores in brackets	Date of rust appearance, as reported from the station	Date of observation, if any, regarding incidence of rust
			27. Patna		
1932-33	September 15—February 21	January 18—21 (1)	No spores	No information ...	January 4th week (traces)
1933-34	October 28—February 15	January 14—18 (1)	...	No rust	
1934-35	October 15—February 27	No spores	No spores	January 4th week ...	February 22 (traces)
1935-36	October 15—March 16 ...	December 26—30 (2)	January 20—24 (1)	No information ...	February 5 (traces)
1936-37	November 27—April 9 ...	December 31—January 3(1)	December 31—January 3(1)	No information ...	February 2—4 (0-1 per cent)
1937-38	December 1—March 20 ...	January 3—6 (1)	January 15—18 (1)	February 2 ...	March 6—7 (traces—100 per cent)
			28. Sabour		
1932-33	September 15—February 19	January 29—February 2 (1)	January 29—February 2 (1)	February 15	
1933-34	November 14—March 8 ...	January 11—14 (2)	No spores (January 11—14) (*) (1)	January 23	January 23 (traces)
1934-35	October 15—March 15 ...	January 21—24 (2)	February 18—21 (1)	March 4	
1935-36	October 16—March 16 ...	December 17—20 (1)	No sprores January 20—24 (9) (Not full two weeks	February 2 ...	February 3 (traces)
1936-37	November 26—April 19 ...	December 27—January 1(1)	January 3—7 (1)	January 28	January 27—28 (traces)
1937-38	November 21—March 24	January 23—27 (1)	January 23—27 (1)	February end of 2nd week	March 5 (0-20 per cent)

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TAB X

Year	Period of exposure	Dates of first spore shower. Number of spores in brackets	Dates of spore shower, if any, 4 to 2 weeks before rust appearance. Number of spores in brackets	Date of rust appearance, as reported from the station	Date of observation, if any, regarding incidence of rust
			BENGAL		
		29.	Mymensingh		
1932-33	September 15—December 22	No spores	...	No crop	
1933-34	March 1—14 ...	No spores	...	No rust	
1934-35	October 15—March 12 ...	No spores	...	No rust	
1935-36	October 15—December 31	No spores	...	No rust	
			ASSAM		
			30. Shillong		
1932-33	September 15—January 26	No spores	...	No crop	
			RAJPUTANA		
			31. Ajmer		
1931-32	November 14—March 12	December 31—January 2(1)	...	No rust	
1932-33	December 15—March 5 ...	No spores	...	No information	
1933-34	October 15—February 27	No spores	...	No information	
1934-35	October 15—February 26	No spores	No spores ...	March 7	March 11 (traces)
1935-36	October 5—February 1 ...	No spores	...	No rust	
1936-37	November 4—February 29	No spores	...	No rust	
1937-38	November 10—January 11	No spores	...	No rust	

TAB XV —co

Year	Period of exposure	Dates of first spore shower. Number of spores in brackets	Dates of spore shower, if any, 4 to 2 weeks before rust appearance. Number of spores in brackets	Date of rust appearance, as reported from the station	Date of observation, if any, regarding incidence of rust
			32. Sriganganagar (Bikaner State)		
1934-35	October 30—March 18 ...	No spores	No spores	March 1st week	
1935-36	October 31—March 31 ...	December 31—January 3(1)	December 31—January 3(1)	January 25	
1936-37	November 17—March 18	February 26—March 2 (11)	...	No rust	
1937-38	December 14—April 5 ...	February 25—March 2 (1)	No spores	February 4th week	
			CENTRAL INDIA		
			33. Indore		
1932-33	September 15—January 19	December 22—27 (2)	...	No rust	
1933-34	March 2—15 ...	No spores	...	No rust	
1934-35	October 15—March 14 ...	No spores	...	No information	
1935-36	October 15—March 19 ...	February 3—6 (1)	...	No rust	
1936-37	November 2—March 18 ...	January 21—25 (1)	...	No rust	
1937-38	November 16—March 15	No spores	...	No rust ...	

'ABL XV

Year	Period of exposure	Dates of first spore shower. Number of spores in brackets	Dates of spore shower, if any, 4 to 2 weeks before rust appearance. Number of spores in brackets	Date of rust appearance, as reported from the station	Date of observation, if any, regarding incidence of rust
			CENTRAL PROVINCES		
		34.	**Jubbulpore (Adhartal farm)**		
1931-32	December 8—March 4 ...	No spores	No spores	No information ...	March 3 (traces)
1932-33	September 16—March 2	No spores	...	No information	
1933-34	October 15—January 27	No spores	†	No information ...	March 3 (traces)
1934-35	October 15—March 29 ...	January 21—24 (1)	January 31—February 3 (2)	February 17	February 25 (traces)
1935-36	October 15—March 20 ...	January 4—8 (1)	...	No information	
1936-37	November 7—February 10	January 6—9 (1)	January 23—27 (7)	March 3	February 24 (traces—20 per cent)
1937-38	November 15—January 19	No spores, ...	...	No rust	
			35. Nagpur		
1929-30	January 2—March 19 ...	No spores	...	No rust	
1930-31	January 3—March 20 ...	January 28—February 2 (1)	...	No information	
1931-32	November 20—March 7 ...	No spores	...	No rust	
1933-34	February 28—March 15 ...	No spores	...	No rust	
1934-35	October 18—March 12 ...	January 16—20 (1)	...	No information	
1935-36	November 20—March 11	No spores	...	No rust	
1936-37	November 2—March 18 ...	January 15—19 (16)	...	No information	
1937-38	November 13—March 12	No spores	...	No rust	

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TABLE XV *contd.*

Year	Period of exposure	Dates of first spore shower. Number of spores in brackets	Dates of spore shower, if any, 4 to 2 weeks before rust appearance. Number of spores in brackets	Date of rust appearance, as reported from the station	Date of observation, if any, regarding incidence of rust
			36. Khandwa		
1931-32	December 24—February 25	No spores	...	No rust	
1932-33	October 18—March 16 ...	March 13—16 (1)	...	No rust	
1933-34	October 20—January 26 ...	January 16—20 (1)	...	No information	
			37. Pachmarhi		
1932-33	December 12—February 12	No spores	...	No rust	
1933-34	March 4—17	No spores	...	No rust	
1934-35	October 19—March 19 ...	No spores	...	No information	
1935-36	October 15—March 21 ...	No spores	...	No rust	
1936-37	November 1—April 4 ...	No spores	...	No rust	
1937-38	November 15—March 21	No spores	...	No rust	
			38. Powarkhera near Hoshangabad		
1934-35	November 23—March 14	No spores	...	No information	
1935-36	October 16—March 14 ...	No spores	...	No information	
1936-37	November 8—March 15 ...	No spores	No spores	February 12	
1937-38	November 15—March 21	No spores	...	No rust	

TABLE XV—*contd.*

Year	Period of exposure	Dates of first spore shower. Number of spores in brackets	Dates of spore shower, if any, 4 to 2 weeks before rust appearance. Number of spores in brackets	Date of rust appearance, as reported from the station	Date of observation, if any, regarding incidence of rust
			39. Saugor		
1936-37	December 22—February 25	No spores	...	February 20 ...	February 26 (No yellow but black)
1937-38	November 15—March 20	No spores	...	No rust	
			40. Raipur (Labhandi farm)		
1936-37	November 10—April 2 ...	January 15—19 (1)	...	No rust	
1937-38	November 15—March 17	No spores	...	No rust	
			BOMBAY-DECCAN		
			41. Poona (College farm)		
1931-32	October 15—January 7 ...	No spores	...	No rust	
1932-33	August 5—December 25	No spores	...	No rust	
1933-34	September 21—December 7	November 9—13 (24)	...	No rust	
1934-35	October 22—March 7 ...	No spores	...	No rust	
1935-36	October 14—February 17	No spores	...	No rust	
1936-37	October 15—February 18	No spores	...	No rust	
1937-38	October 1—February 4 ...	December 7—10 (1)	...	No rust	

TAB XV

Year	Period of exposure	Dates of first spore shower. Number of spores in brackets	Dates of spore shower, if any, 4 to 2 weeks before rust appearance. Number of spores in brackets	Date of rust appearance, as reported from the station	Date of observation, if any, regarding incidence of rust
			42. Poona (Observatory tower 120 feet above ground)		
1933-34	September 15—December 3	October 9—12 (2)	...	No crop	
1934-35	November 10—January 23	No spores	...	No crop	
1935-36	October 15—December 21	No spores	...	No crop	
1936-37	October 29—December 14	No spores	...	No crop	
1937-38	November 15—January 17	No spores	...	No crop	
			43. Niphad		
1931-32	October 22—January 17 ...	No spores	...	No rust	
1932-33	August 9—December 12	No spores	...	No rust	
1933-34	September 15—January 15	December 5—12 (1)	...	No rust	
1934-35	October 2—March 5 ...	December 18—21 (7)	...	No rust	
1935-36	October 15—February 18	No spores	...	No rust	
1936-37	October 15—February 19	No spores	...	No rust	
1937-38	October 1—January 28 ...	No spores	...	No rust	
			44. Dharwar		
1931-32	October 22—January 17 ...	No spores	...	No rust	
1932-33	August 12—December 16	No spores	...	No rust	
1933-34	September 15—January 18	October 30—November 3(1)	...	No rust	

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Year	Period of exposure	Dates of first spore shower. Number of spores in brackets	Dates of spore shower, if any, 4 to 2 weeks before rust appearance. Number of spores in brackets	Date of rust appearance, as reported from the station	Date of observation, if any, regarding incidence of rust
			44. Dharwar		
1934-35	September 28—February 15	No spores	...	No rust	
1935-36	October 15—February 16	No spores	...	No rust	
1936-37	September 20—February 20	No spores	...	No rust	
1937-38	October 5—February 8 ...	No spores	...	No rust	
			45. Arbhavi (Belgaum)		
1932-33	August 8—December 15 ...	No spores	...	No rust	
1933-34	September 15—December 31	November 13—17 (1)	...	No rust	
1934-35	October 1—February 11 ...	No spores	...	No rust	
1935-36	October 15—February 18	No spores	...	No rust	
1936-37	September 20—February 15	No spores	...	No rust	
1937-38	October 1—February 22 ...	No spores	...	No rust	

Year	Period of exposure	Dates of first spore shower. Number of spores in brackets	Dates of spore shower, if any, 4 to 2 weeks before rust appearance. Number of spores in brackets	Date of rust appearance, as reported from the station	Date of observation, if any, regarding incidence of rust
			46. **Dohad**		
1931-32	October 24—January 19 ...	No spores	...	No rust	
1932-33	September 3—January 7	No spores	...	No rust	
1933-34	September 27—January 31	November 22—26 (1)	...	No rust	
1934-35	October 1—March 7 ...	No spores	...	No rust	
1935-36	October 20—February 23	December 11—15 (1)	..	No rust	
1936-37	October 15—February 18	No spores	..	No rust	
1937-38	October 1—March 12 ...	No spores	...	No rust	
			47. **Wagra (Gujrat)**		
1932-33	July 20—January 25 ...	No spores	...	No rust	
1933-34	February 10—24 ...	No spores	...	No rust	
			48. **Baroda**		
1932-33	September 21—November23	No spores	...	No rust	
1933-34	September 15—February 19	No spores	...	No rust	
1934-35	September 15—February 12	No spores	...	No rust	
1935-36	October 15—March 13 ...	January 24—28 (1)	...	No rust	
1936-37	October 15—March 23 ...	No spores	...	No rust	
1937-38	October 1—February 4 ...	No spores	...	No rust	

TAB XV

Year	Period of exposure	Dates of first spore shower. Number of spores in brackets	Dates of spore shower, if any, 4 to 2 weeks before rust appearance. Number of spores in brackets	Date of rust appearance, as reported from the station	Date of observation, if any, regarding incidence of rust
			49. Broach		
1934-35	October 1—February 28 ...	January 24—28 (6)	...	No rust	
1935-36	October 21—February 18	No spores	...	No rust	
1936-37	October 21—February 27	No spores	...	No rust	
1937-38	October 1—February 4 ...	No spores	...	No rust	
			50. Jagudan (Mehsana)		
1932-33	October 7—December 8	No spores	...	No rust	
1933-34	September 15—January 28	November 14—17 (1)	...	No rust	
1934-35	September 19—March 3	No spores	...	No rust	
1935-36	October 15—February 17	No spores	...	No rust	
1936-37	October 15—February 18	No spores	...	No rust	
1937-38	October 1—March 31 ...	No spores	...	No rust	

TABLE XV.

Year	Period of exposure	Dates of first spore shower. Number of spores in brackets	Dates of spore shower, if any, 4 to 2 weeks before rust appearance. Number of spores in brackets	Date of rust appearance, as reported from the station	Date of observation, if any, regarding incidence of rust
			51. Amreli		
1932-33	October 10—January 12 ...	No spores	...	No rust	
1933-34	January 2—February 2 ...	January 26—30 (1)	...	No rust	
1934-35	September 15—February 22	No spores	...	No rust	
1935-36	October 16—February 16	No spores	...	No rust	
1936-37	October 15—February 26	No spores	...	No rust	
1937-38	October 2—March 14 ...	December 6—10 (1)	...	No rust	
			HYDERABAD-DECCAN		
			52. Parbhani		
1932-33	August 4—November 7 ...	No spores	...	No rust	
1933-34	September 18—January 31	No spores	...	No rust	
1934-35	September 15—March 10	No spores	...	No rust	
1935-36	October 15—March 3 ...	No spores	...	No rust	
1936-37	December 25—March 27	No spores	...	No rust	
1937-38	October 7—February 10 ...	No spores	...	No rust	

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Year	Period of exposure	Dates of first spore shower. Number of spores in brackets	Dates of spore shower, if any, 4 to 2 weeks before rust appearance. Number of spores in brackets	Date of rust appearance, as reported from the station	Date of observation, if any, regarding incidence of rust
			53. Himayatsagar near Hyderabad		
1932-33	July 22—January 9	No spores	...	No rust	
1933-34	September 21—January 9	September 21—24 (1)	...	No rust	
1934-35	September 19—February 11	No spores	...	No rust	
1935-36	October 15—February 15	January 13—17 (4)	...	No rust	
1936-37	October 16—February 15	No spores	...	No rust	
1937-38	October 19—January 27 ...	No spores	...	No rust	
			54. Raichur		
1932-33	July 16—November 16 ...	No spores	...	No crop	
			MADRAS		
			55. Bellary (Hagari farm)		
1932-33	July 15—November 17 ...	No spores	...	No rust	
1933-34	September 15—January 15	October 20—23 (1)	...	No rust	
1934-35	August 17—February 22 ...	February 18—22 (4)	...	No rust	
1935-36	June 15—February 21 ...	October 18—22 (1)	...	No rust	
1936-37	August 12—March 31 ...	No spores	...	No rust	
1937-38	August 20—March 1 ...	No spores	...	No rust	

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Year	Period of exposure	Dates of first spore shower. Number of spores in brackets	Dates of spore shower, if any, 4 to 2 weeks before rust appearance. Number of spores in brackets	Date of rust appearance, as reported from the station	Date of observation, if any, regarding incidence of rust
			56. Coimbatore		
1932-33	July 15—December 19 ...	August 18—22 (2)	...	No rust	
1933-34	September 18—February 1	No spores	...	No rust	
1934-35	May 18—February 18 ...	No spores	...	No rust	
1935-36	October 15—February 18	No spores	...	No rust	
1936-37	August 20—February 15 ...	No spores	...	No rust	
1937-38	August 17—January 28 ...	No spores	...	No rust	
			57. Guntur		
1932-33	July 15—November 15 ...	No spores	...	No rust	
1933-34	September 15—January 16	No spores	...	No rust	
1934-35	July 17—February 19 ...	No spores	...	No rust	
1935-36	June 14—February 25 ...	No spores	...	No rust	
1936-37	August 15—March 9 ...	November 28—December 1 (1)	...	No rust	
1937-38	September 2—January 17	No spores	...	No rust	
			58. Koilpatti		
1932-33	July 25—December 30 ...	No spores	...	No crop	

XV

Year	Period of exposure	Dates of first spore shower. Number of spores in brackets	Dates of spore shower, if any, 4 to 2 weeks before rust appearance. Number spores in brackets	Date of rust appearance, as reported from the station	Date of observation, if any, regarding incidence of rust
			59. Anthiyur		
1936-37	August 22—January 25 ...	No spores	...	No rust	
			60. Udumalpet		
1937-38	September 7—February 18	No spores	...	No rust	
			MYSORE STATE		
			61. Hebbal near Bangalore		
1932-33	October 2—February 15 ...	No spores ...	...	No rust	
1933-34	September 15—December 27	November 7—11 (1)	...	No rust	
1934-35	June 16—January 18 ...	December 1—5 (2)	...	No rust	
1935-36	September 17—January 2	No spores	...	No rust	
1936-37	September 25—March 20	October 9—13 (1)	...	No rust	
1937-38	September 27—March 4	No spores	...	No rust	

Year	Period of exposure	Dates of first spore shower. Number of spores in brackets	Dates of spore shower, if any, 4 to 2 weeks before rust appearance. Number spores in brackets	Date of rust appearance, as reported from the station	Date of observation, if any, regarding incidence of rust
			62. Mandya (Mysore)		
1932-33	October 22—January 24 ...	December 20—23 (1)	...	No rust	
1933-34	September 19—February 4	November 13—18 (4)	...	No rust	
1934-35	May 15—February 17 ...	No spores	...	No rust	
1935-36	June 17—November 21 ...	No spores	...	No rust	
1936-37	August 15—March 29 ...	No spores	...	No rust	
1937-38	August 20—February 28	No spores	...	No rust	
			63. Hiriyur (Chitaldroog)		
1932-33	October 14—January 17 ...	January 10—14 (1)	...	No rust	
1933-34	September 21—January 11	No spores	...	No rust	
1934-35	May 15—July 16 February 5—19	No spores	...	No rust	
1935-36	June 20—February 25 ...	No spores	...	No rust	
1936-37	August 15—January 23 ...	No spores	...	No rust	
1937-38	August 20—January 26 ...	No spores	...	No rust	

Note.—Slides were exposed in aeroscopes at 62 stations. At Poona, two aeroscopes (Nos. 41 and 42) were exposed, hence the total number comes to 63

TABLE XIX

Summary of data given in Table XVIII

Serial number	Province and name of station	Number of years during which slides were exposed	Number of years when spore showers took place	Number of years when spores were caught 4 to 2 weeks before rust appearance	Number of years when no spores could be detected 4 to 2 weeks before rust appearance	Number of years when no rust appeared or no information was received regarding rust appearance
	PUNJAB					
1	**Lyallpur**	9	9	3	6	None
2	**Gurdaspur** ...	7	7	3	4	None
3	**Rupar**	6	5	1*	...	4
4	**Hoshiarpur** ...	7	6	3	4	None
5	**Rawalpindi** ...	6	6	2	4	None
6	**Simla**	6	6	6	None	None
7	**Khanewal** ...	5	5	4	1	None
8	**Karnal**	5	5	2	3	None
	BALUCHISTAN					
9	**Quetta**	5	2	...	1	4
	N.-W. F. PROVINCE					
10	**Peshawar**	3	1	1	2	None
	SIND					
11	**Karachi**	1	No spores	...	...	1
12	**Sakrand**	6	3	1	2	3
	DELHI					
13	**Delhi**	2	2	Neither	2	Neither
	UNITED PROVINCES					
14	**Agra**	9	8	3	6	None
15	**Gorakhpur** ...	8	8	4	3	1
16	**Allahabad** ...	3	2	2	1	None

* No slides were exposed during that period in one of the years

TABLE XIX—*contd.*

Serial number	Province and name of station	Number of years during which slides were exposed	Number of years when spore showers took place	Number of years when spores were caught 4 to 2 weeks before rust appearance	Number of years when no spores could be detected 4 to 2 weeks before rust appearance	Number of years when no rust appeared or no information was received regarding rust appearance
	UNITED PROVINCES—*contd.*					
17	**Cawnpore** ...	8	7	2	4	2
18	**Bareilly**	6	5	4	2	None
19	**Shahjahanpur** ...	6	6	2	1	3
20	**Almora**	1	1	1	...	...
21	**Tarikhet**	5	5	1	1	3
22	**Jhansi**	5	5	3*	...	1
23	**Benares**	5	5	1	4	None
24	**Fyzabad**	4	2	...	3	1
25	**Dehradun** ...	3	3	1	2	None
	BIHAR					
26	**Pusa**	7	6	4	3	
27	**Patna**	6	5	3	2	
28	**Sabour**	6	6	4	2	None
	BENGAL					
29	**Mymensingh** ...	4	None	...	...	4
	ASSAM					
30	**Shillong**	1	No spores	...	...	1†
	RAJPUTANA					
31	**Ajmer**	7	1	...	1	6
32	**Sriganganagar** ...	4	3	1	2	1

* No slides were exposed during that period in one of the years
There was no crop that year

TABLE XIX—*contd.*

Serial number	Province and name of station	No. of years during which slides were exposed	No. of years when spore showers took place	No. of years when spores were caught 4 to 2 weeks before rust appearance	No. of years when no spores could be detected 4 to 2 weeks before rust appearance	No. of years when no rust appeared or no information was received regarding rust appearance
	CENTRAL INDIA					
33	**Indore**	6	3	...	...	6
	CENTRAL PROVINCES					
34	**Jubbulpore** ...	7	3	2*	...	4
35	**Nagpur**	8	3	...	...	8
36	**Khandwa**	3	2	...	...	3
37	**Pacchmarhi** ...	6	None	...	...	6
38	**Powarkhera** ...	4	None	...	1	3
39	**Saugor**	2	Neither	...	...	2
40	**Raipur**	2	1	...	...	2
	BOMBAY-DECCAN					
41	**Poona (College farm)**	7	2	...	...	7
42	**Poona (Observatory tower 120 feet above ground)**	5	1	...	...	5‡
43	**Niphad**	7	2	...	...	7
44	**Dharwar**	7	1	...	...	7
45	**Arbhavi**	6	1	...	...	6
46	**Dohad**	7	2	...	...	7
47	**Wagra**	2	Neither	...	...	2
48	**Baroda**	6	1	...	...	6
49	**Broach**	4	1	...	...	4
50	**Jagudan**	6	1	...	...	6
51	**Amreli**	6	2	...	...	6

* No slides were exposed during that period in one of the years

‡ No crop is sown at Poona (Observatory)

TABLE XIX—*contd.*

Serial number	Province and name of station	No. of years during which slides were exposed	No. of years when spore showers took place	No. of years when spores were caught 4 to 2 weeks before rust appearance	No. of years when no spores could be detected 4 to 2 weeks before rust appearance	No. of years when no rust appeared or no information was received regarding rust appearance
	HYDERABAD-DECCAN					
52	**Parbhani** ...	6	None		...	6
53	**Himayatsagar** ...	6	2	...	...	6
54	**Raichur**	1	No spores		...	1†
	MADRAS					
55	**Bellary (Hagari)** ...	6	3	...	...	...
56	**Coimbatore** ...	6	1	...	...	6
57	**Guntur**	6	1	...	...	6
58	**Koilpatti**	1	No spores	...	...	1†
59	**Anthiyur**	1	No spores	...	...	1
60	**Udumalpet** ...	1	No spores	...	...	1
	MYSORE STATE					
61	**Hebbal (Bangalore)** ...	6	3	...	...	6
62	**Mandya (Mysore)** ...	6	2	...	...	6
‡63	**Hiriyur (Chitaldroog)**	6	1	...	...	6

† There was no crop that year
‡ The total number of stations was 62. At Poona, two aeroscopes were exposed

TABLE XX

'y o. sent up big balloons h. spore catchers), small bal. ıs an Agra appearanc **yellow rust** *during 1929 1938*

Year	Period of kite and balloon flights	Range of height in feet reached by different kites and balloons during the year	Dates on which (a) Spores were first caught and (b) Spores caught 4 to 2 weeks before rust appearance Number of spores in brackets	Height reached by kites or balloons on dates given in previous column and direction of winds	Duration of exposure of slides	Date of rust appearance
1929-30*	February 11 ... (2 balloons only)	1,500 feet and 3,000 feet ...	(a) February 11 (6)†	1,500 feet ; N.N.W.	Nearly 5 min.	January 29
1930-31*	December 16—February 20 (4 balloons only)	1,640 feet to 4,756 feet ...	(a) February 20 (2)†	1,640 feet ; N.W. ...	Nearly 5 min.	January 3
1931-32*	December 3 ... (1 balloon only)	1,673 feet ...	No spores	...	2½ min.	February 2nd week
1931-32	December 3—March 14 ...	400 feet to 4,372 feet ...	(a) December 24 (1)K (b) January 25 (1)B	1,425 feet ; N.W. ... 2,575 feet ;	2¼ h. 30 min.	February 2nd week
1932-33	December 12—March 10	654 feet to 4,088 feet ...	(a) December 17 (1)K (b) January 21 (1)K	1,310 feet ; N.W. 1,143 feet ; N.W. and N.	2¼ h. ... 2¼ h.	February 15

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TAB XX—c

Year	Period of kite and balloon flights	Range of height in feet reached by different kites and balloons during the year	Dates on which (*a*) Spores were first caught and (*b*) Spores caught 4 to 2 weeks before rust appearance Number of spores in brackets	Height reached by kites or balloons on dates given in previous column and direction of winds	Duration of exposure of slides	Date of rust appearance
1933-34	December 15—January 31	450 feet to 3,300 feet ...	(*a*) December 30 (1)K (*b*) No spores	1,150 feet ; S. and S.E. ...	$1\frac{3}{4}$ Hrs. ...	February 2
1934-35	November 20—March 14	825 feet to 3,290 feet ...	(*a*) January 21 (1)B (*b*) February 7 (1)K	1,640 feet ; N.W. ... 825 feet ; S.W. ...	$1\frac{1}{4}$ Hrs. 2 Hrs.	February 24
1935-36	November 15—February 29	1,000 feet to 3,280 feet ...	(*a*) January 4 (1)K (*b*) No spores	1,300 feet ; W. ...	$1\frac{1}{2}$ Hrs. ...	January 15
1936-37	November 17—March 1 ...	1,000 feet to 2,300 feet ...	(*a*) January 4 (1)K (*b*) No spores	...	...‡	February 15
1937-38	November 15—February 22	800 feet to 2,000 feet ...	(*a*) January 4 (1)K (*b*) No spores	...	...‡	February 19

‡ Slides posed to 2 ho

TABLE XX

Summary of data given in Map Nos. 95 to 118 in relation to the dissemination of **yellow rust**

Map number	Year	Height of the wind in feet above sea level	Date of wind trajectory	Dates of spore shower soon after the wind. Dates of subsequent showers, if any, 14 to 10 days or so before rust appearance within brackets	Date of rust appearance, as reported from the station. Incidence † within brackets	Area or station where rust had appeared at least 15 days earlier. Dates of rust appearance or incidence within brackets
				PUNJAB		
				Lyallpur (605 feet above sea level)		
95	1933-34 ...	3,280	December 5 ...	...	December 31 ...	Simla ((November 20)
				Hoshiarpur (702 feet above sea level)		
96	1937-38 ...	1,640	February 4 ...	...	February 22 ...	Gurdaspur (January 20)
	1937-38 ...	3,280	February 4 ...	...	February 22 ...	Gurdaspur (January 20)
	1937-38 ...	4,920	February 4 ...	...	February 22 ...	Gurdaspur (January 20)
97	1936-37 ...	6,560	December 10 ...	...	January 5 ...	Simla (November 17)
				Rawalpindi (1,674 feet above sea level)		
98	1933-34 ...	3,280	February 15 ...	...	March 1 ...	Simla (November 20)
				Karnal (900 feet above sea level)		
99	1936-37 ...	1,640	January 6 ...	(...) (January 11—14) ...	January 22 ...	Simla (November 17)
100	1936-37 ...	3,280	December 23 ...	(...) (January 11—14) ...	January 22 ...	Simla (November 17)
101	1936-37 ...	4,920	January 5 ...	(...) (January 11—14) ...	January 22 ...	Lyallpur (December 20)
	1936-37 ...	6,560	January 5 ...	(...) (January 11—14) ...	January 22 ...	Lyallpur (December 20)

† Observations made by members of the Rust Research Staff or occasionally the writer. Range of crop infection relates to different fields and on different varieties in that locality

TABLE XX 'd.

Map number	Year	Height of the wind in feet above sea level	Date of wind trajectory	Dates of spore shower soon after the wind. Dates of subsequent showers, if any, 14 to 10 days or so before rust appearance within brackets	Date of rust appearance, as reported from the station. Incidence within brackets	Area or station where rust had appeared at least 15 days earlier. Dates of rust appearance or incidence within brackets
				SIND		
				Sakrand (120 feet above sea level)		
102	1935-36 ...	1,640	February 9 ...	...	February 28 ...	Dehradun (December 21)
				DELHI		
				Delhi (714 feet above sea level)		
103	1937-38 ...	1,640	January 15 ...	...	February 2 ...	Bareilly (January 1—2 ; traces)
				UNITED PROVINCES		
				Agra (554 feet above sea level)		
104	1934-35 ...	1,640	January 30 ...	...	February 24 ...	Central Nepal (December 23—24 ; 20-25 per cent) Bahraich (January 4)
105	1936-37 ...	1,640	January 16 ...	**January 14—17* ... (February 3—6)	February 15 ...	Lyallpur (December 20)
106	1936-37 ...	3,280	January 30 ...	(...) ... ... (February 3—6)	February 15 ...	Lyallpur (December 20)
107	1937-38 ...	4,920	February 2 ...	...	February 19 ...	Bareilly (January 1—2 ; traces)
108	1932-33 ...	6,560	January 16 ...	(...) ... (February 4—7)	February 15 ...	Simla (November 25)

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TAB XX!

Map number	Year	Height of the wind in feet above sea level	Date of wind trajectory	Dates of spore shower soon after the wind. Dates of subsequent showers, if any, 14 to 10 days or so before rust appearance within brackets	Date of rust appearance, as reported from the station. Incidence within brackets	Area or station where rust had appeared at least 15 days earlier. Dates of rust appearance or incidence within brackets
				Gorakhpur (257 feet above sea level)		
109	1934-35 ...	1,640	January 4 ...	...	January 28 ... (January 28 ; traces)	Central Nepal (December 23—24 ; 20-25 per cent)
	1934-35 ...	3,280	January 4 ...	...	January 28 ... (January 28 ; traces)	Central Nepal (December 23—24 ; 20-25 per cent.)
	1934-35 ...	4,920	January 4 ...	...	January 28 ... (January 28 ; traces)	Western Nepal (November 30 ; traces) Central Nepal (December 23—24 ; 20-25 per cent)
	1934-35 ...	6,560	January 4 ...	...	January 28 ... (January 28 ; traces)	Western Nepal (November 30 ; traces) Central Nepal (December 23—24 ; 20-25 per cent)
				BIHAR		
				Pusa (188 feet above sea level)		
110	1934-35 ...	1,640	December 21 ...	...	January 7 ...	Central Nepal (December 23-24 ; 20-25 per cent)
111	1934-35 ...	3,280	December 19 ...	...	January 7 ...	Central Nepal (December 23—24 ; 20-25 per cent)
	1934-35 ...	4,920	December 19 ...	...	January 7	Central Nepal (December 23—24 ; 20-25 per cent)
	1934-35 ...	6,560	December 19 ...	...	January 7 ...	Central Nepal (December 23—24 ; 20-25 per cent)

TABLE XX

Map number	Year	Height of the wind in feet above sea level	Date of wind trajectory	Dates of spore shower soon after the wind. Dates of subsequent showers, if any, 14 to 10 days or so before rust appearance within brackets	Date of rust appearance, as reported from the station. Incidence within brackets	Area or station where rust had appeared at least 15 days earlier. Dates of rust appearance or incidence within brackets
				Pusa (188 feet above sea level)—*Contd.*		
112	1935-36 ...	1,640	January 2 ...	January 3—7 ... (January 3—7)	January 20 ...	Central Nepal (December 28 ; 60 per cent)
113	1935-36 ...	3,280	December 31 ...	January 3—7 ... (January 3—7)	January 20 ...	Central Nepal (December 28 ; 60 per cent)
114	1937-38 ...	6,560	January 17 ...	Janurary 17—20†† ...	February 7 ...	Bareilly (January 1—2 ; traces)
				Sabour (122 feet above sea level)		
115	1934-35 ...	1,640	February 9 ...	(...) ... (February 18—21 and 21—25)	March 4 ...	Central Nepal (December 23—24 ; 20-25 per cent) Pusa (January 7)
116	1934-35 ...	3,280	February 14 ...	(...) ... (February 18—21 and 21—25)	March 4 ...	Western Nepal (November 30 ; traces) Central Nepal (December 23—24 ; 20-25 per cent) Gonda (January 27 ; 2 per cent) Pusa (January 7)
	1934-35 ...	4,920	February 14 ...	February 18—21 ... ... (February 18—21 and 21—25)	March 4 ...	Central Nepal (December 23—24 ; 20-25 per cent) Gonda (January 27 ; 2 per cent) Pusa (January 7)
	1934-35 ...	6,560	February 14 ...	February 18—21 ... (February 18—21 and 21—25)	March 4 ...	Central Nepal (December 23—24 ; 20-25 per cent)

TAB. XX con

Map number	Year	Height of the wind in feet above sea level	Date of wind trajectory	Dates of spore shower soon after the wind. Dates of subsequent showers, if any, 14 to 10 days or so before rust appearance within brackets	Date of rust appearance, as reported from the station. Incidence within brackets	Area or stations where rust had appeared at least 15 days earlier. Dates of rust appearance or incidence within brackets
				CENTRAL PROVINCES		
				Jubbulpore (1,289 feet above sea level)		
117	1936-37 ...	1,640	January 13 ...	January 13—16 and 16—20 ... (January 30—February 3) ...	March 3 ... (February 24 ; traces 20 per cent)	Simla (November 17)
118	1936-37 ...	3,280	January 17 ...	January 16—20 and **20—23 (January 30—February 3)	March 3 ... (February 24 ; traces —20 per cent)	Simla (November 17)
	1936-37 ...	4,920	January 17 ...	January 20—23 and 23—27 ... (January 30—February 3)	March 3 ... (February 24 ; traces —20 per cent)	Simla (November 17)

TABL XXII

Su a of da of 2 77 's r the c emination of **yellow rus** *ring 1932 to 1938*

Year	Date of rust appearance, as reported from the station. Incidence* where known within brackets	Dates of spore shower, if any, nearly 4 to 2 weeks before rust appearance; those only 14 to 10 days or so earlier in brackets	Period of wind trajectories	Number of winds					Number of relevant winds followed by spore showers	Stations of earlier rust appearance passed over by relevant winds. Ref. Tables XVIII and XXI	Total number of possibly‡ relevant winds, i.e., from the hills. Those followed by spore showers within brackets
				Studied	Found to be relevant†						
					a	b	c	d			
			PUNJAB								
			1. Lyallpur								
1932-33	February 20 ...	No spores ...	January 20 to February 5	63	0	0	0	0	...	...	1
1933-34	December 31 ...	No spores ...	November 30 to December 14	56	0	0	0	1	0	Simla ...	0
1934-35	March 1st week ...	February 11—14 ...	February 1—14 ...	49	0	0	0	0	...	...	3 (0+1?)
1935-36	January 27 ...	January 7—10 and 10—14	December 27 to January 12	52	0	0	0	0	...	...	1
1936-37	December 20 ...	No spores (December 7—10)	November 20 to December 5	52	0	0	0	0	...	...	4
1937-38	January 17 ...	No spores ...	December 17 to January 1	48	0	0	0	0	...	...	7

TABLE XXI

Year	Date of rust appearance, as reported from the station. Incidence where known within brackets	Dates of spore shower, if any, nearly 4 to 2 weeks before rust appearance; those only 14 to 10 days or so earlier in brackets	Period of wind trajectories	Number of winds: Studied	Found to be relevant: a	b	c	d	Number of relevant winds followed by spore showers	Stations of earlier rust appearance passed over by relevant winds. Ref. Tables XVIII and XXI	Total number of possibly relevant winds, i.e., from the hills. Those followed by spore showers within brackets
			2. Hoshiarpur**								
1933-34	January 1st week ...	No spores ...	December 1—15 ...	59	0	0	1	4	0	Simla ...	12
1934-35	February 1st half ...	No spores ...	January 1—31 ...	119	0	7	1	2	0	Simla, Gurdaspur, Bareilly, W. Nepal	40
1935-36	January 1st half ...	No spores ...	December 1—31 ...	117	0	0	0	0	...	...	40
1936-37	January 5 ...	(January 1—5) December 9—12 ...	December 5—20 ...	58	0	5	2	1	0+1 ?	Simla ...	27 (4+4 ?)
1937-38	February 22 ...	January 31 to February 4	January 22 to February 6	50	0	0	0	4	0	Gurdaspur ...	36 (6+10 ?)
			3. Rawalpindi**								
1933-34	March 1 ...	No spores	February 1—15 ...	45	2	0	0	0	...	Simla ...	4
1934-35	February 4th week	January 28 to February 1	January 21 to February 9	44	0	0	0	0	...	...	17 (0+5 ?)
1935-36	February 10 ...	{January 21—24 (January 31—February 3)}	January 10—24 ...	44	0	0	0	0	...	...	3 (1+2 ?)
1936-37	January 19 ...	No spores ...	December 19 to January 4	44	0	0	0	0	...	...	13
1937-38	February 24 ...	No spores ...	January 24 to February 8	42	0	0	0	0	...	...	11

'AB XX 'on

Year	Date of rust appearance, as reported from the station. Incidence where known within brackets	Dates of spore shower, if any, nearly 4 to 2 weeks before rust appearance; those only 14 to 10 days or so earlier in brackets	Period of wind trajectories	Number of winds: Studied	Found to be relevant: a	b	c	d	Number of relevant winds followed by spore showers	Stations of earlier rust appearance passed over by relevant winds. Ref. Tables XVIII and XXI	Total number of possibly relevant winds, i.e., from the hills. Those followed by spore showers within brackets
			4. Karnal								
1933-34	January 14 ...	No spores ...	December 14—29 ...	63	0	2	1	0	0	Simla ...	6
1934-35	February 20 ...	No spores (February 7—11) ...	January 20 to February 2	53	1	1	0	4	0	Simla, Bareilly, Bahraich, W. Nepal	6
1935-36	January 7 ...	December 16—19 ...	December 7—23 ...	60	0	0	0	0	...	...	22 (5+8 ?)
1936-37	January 22 ...	January 4—7 (January 11—14) ...	December 22 to January 6	60	0	3	0	2	0+1 ?	Simla, Lyallpur	27 (8+11 ?)
1937-38	January 16 ...	No spores ...	December 16—31 ...	50	0	0	0	0	...	...	29
			SIND								
			5. Sakrand								
1934-35	February 26 ...	February 3—6 ...	January 26 to February 8	54	0	0	0	0	...	...	3 (1)
1935-36	February 28 ...	No spores ...	January 28 to February 11	36	0	1	0	0	0	Dehradun, Agra	0
1936-37	March 13 ...	No spores ...	February 13—28 ...	50	0	0	0	0	...	...	1

'AB XX contd.

Year	Date of rust appearance, as reported from the station. Incidence where known within brackets	Dates of spore shower, if any, nearly 4 to 2 weeks before rust appearance; those only 14 to 10 days or so earlier in brackets	Period of wind trajectories	Number of winds: Studied	Found to be relevant: a	b	c	d	Number of relevant winds followed by spore showers	Stations of earlier rust appearance passed over by relevant winds. Ref. Tables XVIII and XXI	Total number of possibly relevant winds, i.e., from the hills. Those followed by spore showers within brackets
			DELHI								
			6. Delhi								
1937-38	February 2 ...	No spores ...	January 2—17 ...	61	0	0	0	1	0	Bareilly	17
			UNITED PROVINCES								
			7. Agra								
1932-33	February 15 ...	No spores (February 4—7) ...	January 16 to February 1	68	6	4	2	0	0+2?	Almora, Simla	9
1933-34	February 2 ...	No spores (January 21—24) ...	January 2—16 ...	54	0	2	0	1	0	Simla, Lyallpur	3
1934-35	February 24 ...	No spores ...	January 24 to February 9	67	0	5	0	1	0	Simla, Gurdaspur, Bahraich, Pusa, Central Nepal	4
1935-36	January 15 ...	December 17—19 ...	December 15—29 ...	60	0	0	0	0	...	...	6
1936-37	February 15 ...	January 14—17 February 3—6 ...	January 15—30 ...	64	0	2	4	1	0	Lyallpur, Hoshiarpur	10
1937-38	February 19 ...	January 30 to February 3	January 19 to February 3	57	0	1	2	1	0+1?	Bareilly, Karnal	4 (2+1?)

'AB XXII ontd

Year	Date of rust appearance, as reported from the station. Incidence where known within brackets	Dates of spore shower, if any, nearly 4 to 2 weeks before rust appearance; those only 14 to 10 days or so earlier in brackets	Period of wind trajectories	Number of winds: Studied	Found to be relevant: a	b	c	d	Number of relevant winds followed by spore showers	Stations of earlier rust appearance passed over by relevant winds. Ref. Tables XVIII and XXI	Total number of possibly relevant winds, i.e., from the hills. Those followed by spore showers within brackets
			8. Gorakhpur**								
1933-34	February 1st or 2nd week (January 15; traces)	December 13—16 ...	December 15—29 ...	60	0	7	2	0	0	Simla ...	29
1934-35	January 28 ...	No spores ...	December 28 to January 12 ...	64	0	11	0	9†	0+1 ?	Western and Central Nepal	11
1935-36	January 26 ...	December 23—26 ...	December 25 to January 9	61	0	0	0	6*	0	Central Nepal	19 (0+1 ?)
1937-38	January 27 ...	January 3—6 ...	December 27 to January 12 ...	58	0	0	0	0	...	...	14 (1+1 ?)
			BIHAR								
			9. Pusa								
1932-33	February 3 ...	No spores ...	January 4—19 ...	64	0	5	0	2	0	Almora, Simla	11
1933-34	January 19 ...	January 1—4 ...	December 19 to January 2	60	0	5	0	0	0	Simla	31 (4+7 ?)
1934-35	January 7 ...	No spores ...	December 7—22 ...	62	0	0	0	18‡	0	Western and Central Nepal	2

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TABLE XXII—*co*

Year	Date of rust appearance, as reported from the station. Incidence where known within brackets	Dates of spore shower, if any, nearly 4 to 2 weeks before rust appearance; those only 14 to 10 days or so earlier in brackets	Period of wind trajectories	Number of winds					Number of relevant winds followed by spore showers	Stations of earlier rust appearance passed over by relevant winds. Ref. Tables XVIII and XXI	Total number of possibly relevant winds, i.e., from the hills. Those followed by spore showers within brackets
				Studied	Found to be relevant						
					a	b	c	d			
			9. Pusa—*contd.*								
1935-36	January 20 ...	January 3—7 ...	December 20 to January 3	60	0	0	0	8†	2	Central Nepal	22 (1+2 ?)
1936-37	February 3 ...	No spores ...	January 3—19 ...	66	0	0	3	1	0	Lyallpur	25
1937-38	February 7 ...	January 17—20 ...	January 7—22 ...	51	0	0	0	2	0	Bareilly	20 (3+3 ?)
			10. Sabour								
1932-33	February 15 ...	January 29 to February 2 (February 2—5)	January 15—30 ...	51	0	0	0	6	4	Gorakhpur	18 (9)
1933-34	January 23 ...	No spores (January 11—14	December 23 to January 6	59	0	0	0	0	...	...	20 (1)
1934-35	March 4 ...	February 18—21 ...	February 4—17 ...	55	18	7	6	4	8	Western and Central Nepal, Fyzabad, Patna, Pusa, Simla, Bareilly, Gonda, Bahraich, Gorakhpur	2

Central Nepal rop fectio

TABLE XXI *contd.*

Year	Date of rust appearance, as reported from the station. Incidence where known within brackets	Dates of spore shower, if any, nearly 4 to 2 weeks before rust appearance; those only 14 to 10 days or so earlier in brackets	Period of wind trajectories	Number of winds: Studied	Found to be relevant: a	b	c	d	Number of relevant winds followed by spore showers	Stations of earlier rust appearance passed over by relevant winds. Ref. Tables XVIII and XXI	Total number of possibly relevant winds, i.e., from the hills. Those followed by spore showers within brackets
			10. Sabour—*contd.*								
1935-36	February 2 ...	January 20–24 ...	January 1—16 ...	62	0	9†	0	0	0	Central Nepal	4
1936-37	January 28 ...	January 3—7 ...	December 28 to January 12	55	0	1	0	0	0	Simla ...	27 (1+8 ?)
1937-38	February end of 2nd week	January 23—27 ...	January 15—31 ...	57	0	0	0	2	0	Bareilly ...	29 (4+7 ?)
			BENGAL								
			11. Mymensingh								
1937-38	No information ... (February 27; traces—5 per cent)	‡ ...	January 20 to February 4	56	0	0	0	0	‡	...	8
			ASSAM								
			12. Dhubri**								
1936-37	No information ... (January 23; traces)	‡ ...	December 23 to January 7	56	0	0	0	0	‡	...	1

† In Central Nepal 60 per cent crop infection was observed on December 28, 1935

'ABLE XX' d.

Year	Date of rust appearance, as reported from the station. Incidence where known within brackets	Dates of spore shower, if any, nearly 4 to 2 weeks before rust appearance; those only 14 to 10 days or so earlier in brackets	Period of wind trajectories	Number of winds: Studied	Found to be relevant: a	b	c	d	Number of relevant winds followed by spore showers	Stations of earlier rust appearance passed over by relevant winds. Ref. Tables XVIII and XXI	Total number of possibly relevant winds, i.e., from the hills. Those followed by spore showers within brackets
			CENTRAL PROVINCES								
			13. Jubbulpore								
1934-35	February 17 ...	January 31 to February 3 (February 3—7)	January 17 to February 1	57	0	2	0	1	3	Bareilly, Western and Central Nepal	4 (1+1 ?)
1936-37	March 3 ... (February 24; traces—20 per cent)	January 23-27 ... (January 30 to February 3)	January 10-25 ...	64	3	0	0	1	4	Simla, Hoshiarpur	6 (4+2 ?)
			Total ...	2,977	30	80	24	83	21+ 10 ?	...	669 (56—74 ?)

TABLE XXIII

Relevant and Possibly Relevant winds at different heights in relation to the dissemination of **Yellow Rust** *during 1932 to 1938*

Serial number	Province and Station. Altitude in feet above sea level within brackets. Period of study	Height of winds in feet above sea level	Total number of winds studied	Relevant winds : (*a*) Total number, (*b*) Number for specified height only followed by spore showers, (*c*) Number along with winds at other heights followed by spore showers			Possibly† Relevant winds : (*i-iii*) From different hills, (*vi*) Number for specified height only followed by spore showers, (*v*) Number along with winds at other heights followed by spore showers				
				(*a*)	(*b*)	(*c*)	(*i*)	(*ii*)	(*iii*)	(*iv*)	(*v*)
	PUNJAB										
1	**Lyallpur** (685) ...	1,640	80	0	0	0	0	6	1	0	0
	6 years	3,280	83	1	0	0	0	2	1	0	0
		4,920	80	0	0	0	0	2	0	0	0
		6,560	77	0	0	0	0	3	1	0	0
2	**Hoshiarpur*** (782)	1,640	105	7	0	0	0	35	14	0	5
	5 years	3,280	96	6	0	0	0	28	14	0	3
		4,920	99	8	0	0	0	27	8	0	2
		6,560	103	6	0	0	0	19	10	0	0

† Such winds as originated from or passed over hill stations where this rust had been found to oversummer or observed in an advanced stage from year to year, due to early sowings, long before the period of winds, were taken as 'possibly relevant,' as explained under Methods of Study

(*i*) Number of winds coming from Central Nepal

(*ii*) Number of winds coming from Kashmir and Murree hills

(*iii*) Number of winds coming from Siwalik and Kumaon hills

* Situated at foot-hills

Note.—In addition to the number of 'relevant winds' followed by spore showers, as shown in columns (*b*) and (*c*) above, there were 10 such winds at different heights, in relation to which spore showers also occurred but they are not included in those columns because the periods of spore showers were not strictly in accordance with the heights of the winds concerned, as explained under sub-head 10 (*ii*). Similarly, 74 'possibly relevant' winds have not been shown in columns (*iv*) and (*v*). These numbers are, however, included in columns (*a*) and (*i*) to (*iii*). In most of these cases, spore showers took place a day or two earlier than the maximum period reckoned for each height (1,640 to 6,560 ft. above sea level), possibly because of the absence of great disturbance in the air below those winds. It is equally likely that some of those spore showers were caused by winds, from other and unknown sources, which blew during the intervals between daily meteorological observations.

TABLE XXIII—*contd.*

Serial number	Province and Station. Altitude in feet above sea level within brackets. Period of study	Height of winds in feet above sea level	Total number of winds studied	Relevant winds : (a) Total number, (b) Number for specified height only followed by spore showers, (c) Number along with winds at other heights followed by spore showers			Possibly Relevant winds : (i-iii) From different hills, (iv) Number for specified height only followed by spore showers, (v) Number along with winds at other heights followed by spore showers				
				(a)	(b)	(c)	(i)	(ii)	(iii)	(iv)	(v)
3	**Rawalpindi* (1,674)**	3,280	74	2	0	0	0	9	1	0	0
	5 years	4,920	72	0	0	0	0	10	1	0	0
		6,560	73	0	0	0	0	25	2	1	0
4	**Karnal (900)** ...	1,640	71	7	0	0	0	10	22	1	2
	5 years	3,280	74	4	0	0	0	6	14	0	2
		4,920	71	2	0	0	0	11	13	0	6
		6,560	70	1	0	0	0	6	8	0	2
	SIND										
5	**Sakrand (120)** ...	1,640	29	1	0	0	1	2	1	1	0
	3 years	3,280	37	0	0	0	0	0	0	0	0
		4,920	38	0	0	0	0	0	0	0	0
		6,560	36	0	0	0	0	0	0	0	0
	DELHI										
6	**Delhi (714)** ...	1,640	15	1	0	0	0	6	0	0	0
	1 year	3,280	16	0	0	0	0	2	4	0	0
		4,920	16	0	0	0	0	2	2	0	0
		6,560	14	0	0	0	0	0	1	0	0

* Situated at foot-hills

TABLE XXIII—*contd.*

Serial number	Province and Station. Altitude in feet above sea level within brackets. Period of study	Height of winds in feet above sea level	Total number of winds studied	Relevant winds : (*a*) Total number, (*b*) Number for specified height only followed by spore showers, (*c*) Number along with winds at other heights followed by spore showers			Possibly Relevant winds : (*i-iii*) From different hills, (*iv*) Number for specified height only followed by spore showers, (*v*) Number along with winds at other heights followed by spore showers				
				(*a*)	(*b*)	(*c*)	(*i*)	(*ii*)	(*iii*)	(*iv*)	(*v*)
	UNITED PROVINCES										
7	**Agra (554)** ...	1,640	92	21	0	0	1	5	14	0	1
	6 years	3,280	92	3	0	0	0	3	9	0	1
		4,920	93	6	0	0	0	1	2	0	0
		6,560	93	2	0	0	0	1	0	0	0
8	**Gorakhpur* (257)**	1,640	62	12	0	0	10	1	14	1	0
	4 years	3,280	59	10	0	0	8	1	12	0	0
		4,920	62	8	0	0	3	3	8	0	0
		6,560	60	5	0	0	2	1	10	0	0
	BIHAR										
9	**Pusa (188)** ...	1,640	89	9	0	1	13	2	10	0	1
	6 years	3,280	91	10	0	1	18	2	14	0	0
		4,920	90	10	0	0	15	3	9	0	3
		6,560	93	15	0	0	15	0	10	0	4
10	**Sabour (122)** ...	1,640	78	11	0	1	13	0	5	0	2
	6 years	3,280	82	11	0	1	16	2	9	0	6
		4,920	90	11	0	2	22	3	6	0	3
		6,560	89	20	3	5	18	0	6	2	2

* Situated at foot-hills

TABLE XXIII— *contd.*

Serial number	Province and Station. Altitude in feet above sea level within brackets. Period of study	Height of winds in feet above sea level	Total number of winds studied	Relevant winds: (a) Total number, (b) Number for specified height only followed by spore showers, (c) Number along with winds at other heights followed by spore showers			Possibly Relevant winds: (i-iii) From different hills, (iv) Number for specified height only followed by spore showers, (v) Number along with winds at other heights followed by spore showers				
				(a)	(b)	(c)					
	BENGAL										
11	**Mymensingh (62)**	1,640	14								
	1 year	3,280	14								
		4,920	12	0							
		6,560	16	0							
	ASSAM										
12	**Dhubri* (115)** ...	1,640	14	0	‡	‡	0	0	0		
	1 year	3,280	15	0	‡				1		
		4,920	13	0	‡				0		
		6,560	14	0					0		
	CENTRAL PROVINCES										
13	**Jubbulpore (1,289)**	1,640	32	2	2	0				1	0
	2 years	3,280	28	4	3	1				4	0
		4,920	30	1	0	1	0	0	0	0	0
		6,560	31	0	0	0	0	0	0	0	0
	TOTAL		2,977		8	13	11	244	264	11	

‡ No spores were exposed at this station
* Situated at foot-hills

XX

Summar; g in No. 'o: some of the 'ha be
'ga as 'van. 'n **yellow rus**

Map umber		the eet	Date of wind ajectory	Dates of spore shower soon aftc the wind. Dates of subsequen showers, if any, 14 to 10 days or so before rust appearance	Date of rust appearance, reported from station.	Area or st. Date of whe	passed over y tl wind pearance o inc ence wn within l rack
				PUNJAB			
				Lyallpur (605 feet above sea l			
		30	...	February 11—14	st week	Peshawar	
		,920	...	February 11—14	st week	Murree, Rawalpindi	
		6,560	...	February 11—14	st week	N.-W. F. Province	
		1,640	...	January 10—14 ... .. (January 10—14)	27	Afghanistan	
		3,280	...	January 10—14 ... .. (January 10—14)		N.-W. F. Province	
		4,920	...	January 10—14 ... .. (January 10—14)		Suleiman range	
		6,560	...	January 10—14 ... .. (January 10—14)		N.-W. F. Province	
			Rawalpindi (1,674 f	**: above sea l**			
		3,280		January 28—F uary 1 ..	h week	N.-W. F. Province	
	934	4,920		January 28—F uary 1 ..	h week	N.-W. F. Province	
	934	6,560		Ja uary 1 ..	h week	Murree	

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Map number	Year	Height of the wind in feet above sea level	Date of wind trajectory	Dates of spore shower soon after the wind. Dates of subsequent showers, if any, 14 to 10 days or so before rust appearance	Date appea porte stat	Area Dat w
				Rawalpindi (1674 feet above sea level)—*to*		
122	1935-36 ...	3,280	January 20 ...	January 21—24 ... ... (January 31—February 3) ...	February	N.-W
	1935-36 ...	4,920	January 20 ...	January 21—24 ... ... (January 31—February 3)	February	N.-W.
	1935-36 ...	6,560	January 20 ...	January 21—24 ... ... (January 31—February 3)	February	
				UNITED ROVINCES		
				Agra (554 fe above sea level)		
		1,640	Decemb	December 17 19	January 15	a y 2) n 22 2
		3,280	Decemb	December 17 19 ...	January 15	(1 17
	935-36		Decemb	December 17		
			Decemb	December 17		

Table XXV

Earliest date and the usual period of the appearance of yellow rust *in the foot-hills and plains*

Serial number	Province	Name of station	Earliest date of rust appearance, as reported from the station. Incidence† within brackets	Usual period of rust appearance
1	PUNJAB	Gurdaspur* ...	December 27 ...	January 2nd week
2		Hoshiarpur* ...	January 5	January—February
3		Rawalpindi* ...	January 19	February—March
4		Pathankote* ...	(March 6; 2-10 per cent) ...	March 1st—2nd week
5		Rupar ...	January 15	January Middle
6		Lyallpur ...	December 20	January—February
7		Khanewal ...	January 12	February 3rd week
8		Karnal ...	January 7	January 2nd—3rd week
9		Ambala ...	(March 15; 3-40 per cent)	March 1st—2nd week
10		Sialkot ...	(March 3; 5-20 per cent) ..	March 1st—4th week
11		Jullundar ...	(March 17; 10-50 per cent)	March 1st—2nd week
12		Hansi ...	(February 15; traces) ...	February 2nd week—March 1st week
13	N.-W. F. PROVINCE ...	Peshawar* ...	February 1st week ...	February 3rd week
14	SIND ...	Sakrand ...	February 26	End of February—March
15	DELHI ...	Delhi ...	February 2	February 1st week
16	UNITED PROVINCES ...	Debradun* ...	December 21	January 1st week
17		Kotdwara* ...	(December 29; traces) ...	February 1st week
18		Haldwani* ...	(January 2nd week) (January 23; 30 per cent) ...	February 1st week
19		Kathgodam* ...	(February 3; Heavy) ...	January end
20		Gorakhpur* ...	December 31	January 4th week
21		Mailani* ...	(January 5; traces) ...	January—February 1st week

† Observations made by members of the Rust Research Staff or occasionally the writer. Range of crop infection relates to different fields and on different varieties at that locality

* Situated at foot-hills

TABLE XXV—*contd.*

Serial number	Province	Name of station	Earliest date of rust appearance, as reported from the station. Incidence within brackets	Usual period of rust appearance
22		**Gainsari*** ...	(January 3 ; traces) ...	January 1st—4th week
23		**Nautanwa*** ...	(January 4 ; 0·1 per cent) ...	January 1st—3rd week
24		**Naipalganj Road***	(January 1 ; 0·25 per cent)	January Early
25		**Choharpur*** ...	(February 25 ; 25-100 per cent)	January 4th week—February 1st week
26		**Kashipur*‡** ...	(January 21 ; traces—30 per cent)	...
27		**Bellrein*** ...	(December 27 ; traces) ...	January Early—February Early
28		**Najibabad** ...	(December 28 ; traces) ...	January End
29		**Moradabad** ...	(January 22 ; traces) ...	January 3rd week—February 1st week
30		**Shahjahanpur** ...	February 1st week ... (February 1—2 ; 20 per cent)	February 1st—3rd week
31		**Bareilly** ...	(January 1—2 ; traces) ...	January 1st—3rd week
32		**Chandausi** ...	(January 4th week ; Epidemic)	January 1st—4th week
33		**Pilibhit** ...	(January 6 ; traces) ...	January Middle
34		**Barabanki** ...	(December 29 ; traces) ...	January 4th week—February 1st week
35		**Gonda** ...	(January 27 ; 2 per cent) ...	January 4th week
36		**Fyzabad** ...	January 14	January End—February 2nd week
37		**Lucknow** ...	(January 31 ; 5 per cent) ...	January End—February 3rd week
38		**Agra** ...	January 3	February 2nd—3rd week
39		**Cawnpore** ...	February 1st week ...	February—March
40		**Allahabad** ...	January 30	February 1st week
41		**Benares** ...	January 19	January End—February
42		**Jhansi** ...	February 15	February 3rd week

* Situated at foot-hills

‡ At this station rust was observed only once

TABLE XXV—*contd.*

Serial number	Province	Name of station	Earliest date of rust appearance, as reported from the station. Incidence within brackets	Usual period of rust appearance
43	BIHAR ...	Raxaul*‡ ...	(January 12 ; 0-5 per cent)	...
44		Jaynagar* ...	(January 13 ; 3 per cent) ...	January 2nd week
45		Jogbani* ...	(January 18 ; traces) ...	January 3rd—4th week
46		Motihari*‡ ...	(January 22 ; traces)	...
47		Pusa ...	January 7	January—February
48		Patna ...	January 4th week ...	January End—Early February
49		Sabour ...	January 23 ...	January 4th week—February
50		Katihar ...	(January 20 ; one leaf) ...	January 4th week
51		Harinagar‡ ...	(January 11 ; 0-50 per cent)	...
52	BENGAL ...	Mymensingh ...	(February 15 ; traces)	February 1st—4th week
53		Cooch-Behar‡ ...	(February 7—8 ; 0-1 per cent)	...
54	ASSAM ...	Dhubri* ...	(January 23 ; traces) ...	January End—February Middle
55		Fakirgunj*‡ ...	(February 11 ; 0-5 per cent)	...
56	RAJPUTANA ...	Ajmer† ...	March 7	...
57		Sriganganagar ...	January 25	February End—Early March
58	CENTRAL PROVINCES	Jubbulpore ...	February 17	February 4th week
59		Saugor ...	(March 2 ; 5 per cent) ...	March 1st week
60		Powarkhera† ...	February 12	...
61		Piparia‡ ...	(January 11 ; 5 per cent)	...

‡ At this station rust was observed only once

*Situated at foot-hills

† From this station rust was reported only once

Explanatory notes on Map Nos. 95-123. Ref. Tables XXI and XXIV.

(*i*) In order to economise space only portions of maps showing the wind-trajectories have been included

(*ii*) The scale of each map is 1 inch = 341.3 miles

(*iii*) Shaded portions represent hills and hilly tracts

(*iv*) Each wind-trajectory bears the label A, B, or C etc., representing heights of 1640, 3280, 4920 feet above sea level respectively. These heights have been mentioned in the foot-notes to each map

(*v*) Wherever no date of rust appearance was reported from the station concerned information, if available, regarding the incidence of rust on the date of observation by the writer or a member of the Rust Research Staff is given within brackets

PART FIVE

General Discussion and Conclusions

As stated in the previous monograph [Mehta, 1940] there is no source of rust infection locally in the plains at the time of sowing wheat and barley (October-November), yet rusts cause severe epidemics over the greater part of India from year to year.

On account of a long summer, the interval between the harvest and the next sowing in this country is much longer than in temperate climates and varies from 6-7 months according to local weather conditions. During this period there is no inoculum from the previous crops in the plains and, excepting at some places along the sea-shore, no self-sown plants or ratoon tillers from harvested crops exist. At most of the stations in the plains rusts appear 2-3 and even 3-4 months after the time of sowing of the new crop although, as shown by the experiments described in Part One, weather conditions are quite favourable from the start, at any rate, for black and brown rusts. One may conclude, therefore, that rusts are reintroduced into the plains of India every year from sources elsewhere.

The question that naturally arises is, where does the inoculum come from? This question has been partly answered in Parts Two, Three and Four and only such aspects as relate to the dissemination of all the three rusts, in general, are discussed below:

(i) *Usual period of rust appearance in the plains in different parts of the country*

In some of the districts of Peninsular India black rust has been found to break out as early as October-November on wheat sown during July to September. Even on the normal crop (sown in October-November) this rust appears earlier, i.e. by December-January, in Peninsular India than in other parts of the country. In the north black rust usually appears first in the foot-hills of the Nepal range (eastern distrcts of the United Provinces) late in December—early January. In the western districts of the United Provinces it breaks out much later, i.e. in February to early March and the same applies to the Central Provinces. Year after year black rust appears last in the central Punjab, i.e. during March-April.

Brown rust appears in Peninsular India only occasionally but at about the same time as black rust. In the foot-hills of the Nepal range this rust breaks out, in general, a few days before black rust and the same applies to the western districts of the United Provinces and the Central Provinces. In the central Punjab also brown rust appears a few days earlier than black rust but on the whole much later than in other parts of the country.

Yellow rust is not found in the plains of Peninsular India. In other parts of the country, excepting the Central Provinces, it breaks out usually in January-February. In the Central Provinces this rust appears only occasionally and nearly a month later than in the northern parts of the country.

It is important to note that black and brown rusts appear earlier at Karnal, which is situated along the border between the United Provinces and the Punjab, than in the latter.

(ii) Inoculum from other continents

In view of long distances and much later outbreaks of rusts in Europe and America there is little likelihood of inoculum being disseminated to India from those continents. Wheat and barley are harvested in India long before rusts develop in those parts of the world. In Australia there is no yellow rust and the physiologic-race flora of black and brown rusts is entirely different from that of India. None of the physiologic races of these two rusts found in India has been reported from Australia. The same applies to Africa as regards the physiologic-race flora of black rust of wheat, but no information is available from that continent about the other two rusts. It is highly improbable, therefore, that inoculum from either of these two continents could be responsible for initial rust outbreaks in India.

(iii) Inoculum from adjacent countries

It is hardly necessary to consider the possibility of inoculum coming from countries north of India because of the severely cold winter and consequently delayed appearance of rusts. Besides, the Himalayan range is an effective barrier.

The same applies to Afghanistan. In that country wheat is sown during October-November and over the greater part lies buried under snow throughout winter. The harvest takes place in July-August. In this connection it is important to note that, although during the greater part of winter the direction of prevailing winds is from Afghanistan towards Bengal, rusts appear much later in the Punjab than in the United Provinces. If Afghanistan were the source, crops in the Punjab should get rusted earlier than in any other part of the Indo-Gangetic plain.

In Baluchistan wheat and barley are sown at about the same time as in Afghanistan, i.e. during October-November and information obtained by the writer shows that there is no early crop in that country either. Wind data were obtained from the Meteorological Department, Poona, for November to January during 1935 to 1938. There were several winds at different heights from Baluchistan to Bombay-Deccan including the Dharwar area, Gujerat-Kathiawar, Rajputana and the Punjab during those periods. Whereas black rust appears in the south-western parts of Bombay-Deccan fairly early in the season (December-January), the same is not true of the other three areas mentioned above. In fact from Quetta (Baluchistan) itself no rust has ever been reported before the end of April. Rust outbreaks occur rather late (February-March) at Sakrand (Sind) also. In Gujerat-Kathiawar black rust has been occasionally found fairly early, i.e. during December-January, but in Rajputana both brown and black rusts appear much later, and in the Punjab these two rusts break out as late as March-April. It may safely be concluded, therefore, that the inoculum responsible for early outbreaks of black rust in Bombay-Deccan and Gujerat-Kathiawar comes from some other source.

(iv) Sources within the country

In contrast with their total absence in the plains of India during summer and at the time of sowings, rusts are found at various altitudes in the hills during May-June on the crop and on self-sown plants or ratoon tillers from harvested plants throughout the season. Oversummering of rusts in the hills of India is an established fact and they break out on the hill crops very much in advance of infection in the neighbouring plains.

As stated in the previous monograph [Mehta, 1940] the similarity between the physiologic-race flora of the hills and the plains is another proof, and a strong one too, of the fact that the source of all the three rusts under reference lies in the hills.

There is nothing to suggest, however, that at any locality in the plains every field, much less each plant, should get infected by inoculum directly from the hills. In fact this is extremely unlikely to happen. Once the initial infection of a few odd plants has taken place, as a result of inoculum coming down from the hills, rust should spread from plant to plant much faster locally in the plains owing to mild weather. Later on infection may spread from place to place as a result of dissemination by the upper-air currents.

(*v*) *Rôle of upper-air currents in rust dissemination*

Detailed reference has already been made to this aspect of the problem, especially in relation to the spread of black rust from southern Texas and Mexico to the Mississippi Valley and from there to Canada.

The question of the spread of rusts to the various countries of Europe from areas where they are able to overwinter in the uredostage has been discussed before. Reference has also been made to the dissemination of black rust from some of the countries as a result of earlier infection of barberries.

As far as infection with rusts in the plains of this country is concerned, inoculum should reach the upper-air through winds even from ground level in the hills as soon as new crops in those areas become infected. The upward movement of inoculum by anabatic (up-valley) air-currents needs no explanation. In the presence of well-advanced infection on the hill crops, therefore, a fair amount of inoculum should be carried by the upper-air to long distances if there are strong winds.

Similarly, inoculum from places of early rust appearance in the plains should be carried into the upper-air by convection currents during the day time and then disseminated in different directions.

(*vi*) *Speed of upper-air currents and their width*

The speed of winds was not shown in the trajectories, as drawn on the original maps but the distances covered by different winds, during their course from day to day, have been reproduced on Map Nos. 2 to 123 to enable the reader to measure approximately the average speed with the help of the scale shown in the Explanatory Notes to the Maps.

Ramanathan and Ramakrishnan [1939], while dealing with the general circulation of the atmosphere over India and its neighbourhood based on twenty years' observations, have supplied detailed tables giving the 'arithmetic mean speed' of winds during all the twelve months of the year at heights of 0.5 and 1 to 8 kilometers.

With the exception of a few stations, trajectories prepared for these studies relate only to winds up to 2 kilometers, i.e. 6,560 feet above sea level, and their 'arithmetic mean speed' during October to March, the period of growth of the wheat crop in the plains, as recorded by these authors, ranges between 15 to 17 at 1,640 and 3,280 ft. and 16 to 27 miles per hour at 6,560 ft. above sea level.

With regard to the width of winds the Superintending Meteorologist, Upper-Air Observatory, Agra has kindly supplied the following information;

'The wind-trajectories drawn over any region would naturally be representative of the wind flow over a restricted belt only, the width of a belt depending upon various factors such as the wind speed and its variability, the steadiness of its direction, the extent, depth and persistence of the general wind flow. These are indeed very fluctuating factors and therefore any attempt to estimate the width would be more or less arbitrary. With this limitation, one may take 50 miles as only a rough working value for the width of the wind-trajectories.'

(vii) General direction and circulation of winds during winter

Information regarding the general direction of winds during October to March, the period of growth of the wheat crop in the plains of India, has been summarized below from the memoir published by Ramanathan and Ramakrishnan [1939].

October.—At 1 km., air flows from north to south in regions lying approximately to the west of longitude 85° and from south to north to its east. At 2 and 3 km. westerly winds in north India push through to Bengal and Assam.

November.—At 1 and 2 km. there are valley winds in Assam between the Khasi hills and the Himalayas. The land air from north-west India curves round the high pressure area in the central parts of the country and traverses the middle of the Peninsula as a north-easterly current. Wind directions in the south Bay and on the Madras coast are definitely easterly and north-easterly.

December.—During this month no important change is recorded below 3 kilometers.

January.—There are disturbances in north India from west to east with greatest effect in Kashmir and hills of the north and east Punjab. At 1 km. there is a slow drain of cold air from and along the Himalayas towards the head of the Bay of Bengal and also a flow of air down the Brahmaputra valley towards north Bengal. In the south of the Bay and the Peninsula there is an easterly current. At 2 km. winds with high velocity blow in the Gangetic valley, United Provinces, Bihar and Bengal. There is also a strong control of the high mountain system in the north.

February.—Conditions in this month are generally similar to those in January.

March.—Western disturbances continue to pass eastwards across north India. In Gujerat and Bombay-Deccan there is a southward flow, whereas along the east coast it is northwards.

With regard to the circulation of winds these authors have observed that there is a regular seasonal northward and southward movement of the upper-air system which is mainly meridional during winter. Another striking feature of circulation in the region, which covers practically the whole of India, is the great influence exercised by the mountain system in the north up to a level of 6 km., i.e. 19,680 ft. above sea level throughout the year.

(viii) Rôle of katabatic winds in the dispersal of inoculum from the hills

It is well-known that katabatic winds flow down from the hills every night in clear weather. Rust outbreaks in the foot-hills may, in general, be attributed to such winds if there is enough inoculum on 'out of season' plants in the hills or if the hill crops are already infected,

It is not possible to state exactly the duration of katabatic winds, their speed and the distance they are likely to cover from any of the hills in this country owing to lack of anemograph records at intermediate stations. On the authority of the Agricultural Meteorologist, the writer can state that in the case of the Nilgiri and Palni hills the range of katabatic winds may be 30 to 35 miles. With regard to Poona, which is nearly 12 miles from the hills (Western Ghats), the most frequently observed speed of katabatic winds, as recorded by Atmanathan [1931], is about five miles per hour. In the case of the Himalayan range, on account of high altitudes, the range of katabatic winds may be as much as 80 miles and the mean speed about ten miles per hour. If the direction of prevailing winds happens to be the same as that of the katabatic flow, the sphere of influence will extend farther than when these winds are against each other. It may, therefore, be pointed out that the following foot-hill stations mentioned in this monograph are within the reach of katabatic winds :—

Rawalpindi, Hoshiarpur, Gurdaspur, Dehra-Dun, Gorakhpur and several others along the Nepal border, Poona, Mandya and Coimbatore.

(ix) Rust spores in the upper-air in India

As shown in Tables I, IV, XII and XX spores of each of the three rusts of wheat were caught from the upper-air on slides exposed from aeroplanes as well as on balloons and kites. With aeroplane exposures rust spores were caught at heights up to 10,700 ft. above sea level. No exposures were made above that height.

(x) Rate of fall of spores in still air

As stated in Part Two, Ukkelberg [1933] calculated the rate of fall of uredospores of black rust in still air to be $11 \cdot 57 \pm 0 \cdot 03$ and that of brown as $12 \cdot 62 \pm 0 \cdot 07$ mm. per second. For a single spore of black and brown rusts the rate of fall per hour in still air comes to nearly 133 and 149 ft. respectively.

Individual spores of black and brown rusts would, therefore, take nearly 12 and 11 hours respectively to alight on the crops in still air from 1,640 ft. If the air below this height happens to be in movement they would take longer to settle down. Spores adhering to dust particles would reach the ground level much sooner and so would spores in clusters. This question has been fully discussed under sub-head 10 (ii) of Part Two.

Judging from their measurements the rate of fall of individual spores of yellow rust would be nearly the same as that of brown rust.

(xi) Fall of spores with rain drops

The part played by rain in bringing down inoculum from the upper-air to ground level is of considerable importance. Although uredospores would alight on the crop none may reach the slide inside an aeroscope unless there is wind at the ground level splashing rain into its box. Even then some of the spores may drip off the slide with rain drops.

Information was therefore obtained to see how far rain could account for cases of rust appearance in the absence of detection of spores on aeroscope-slides. For this purpose the following eight stations were selected :—Lyallpur, Delhi, Agra, Pusa, Jubbulpore, Poona, Mandya and Coimbatore. Every case of rust appearance, not preceded by a spore shower, was examined to make sure if any of the 'possibly relevant' winds that blew over these stations was followed by rain prior to the commencement of the incubation period. Data of rain and

other necessary information are given in Appendix F. Only such winds are included in the Appendix as were followed by rain. At five stations out of eight, which have been left out of the Appendix, either there were no 'possibly relevant' winds without spore showers or there was no rain following the winds just before the commencement of the incubation period.

Similar information was also collected for such 'relevant' winds out of those reproduced on Map Nos. 2 to 123, as were not followed by spore showers. Data obtained have been supplied in Appendix G, separately for each rust.

While it is not possible to draw any general conclusion from the data presented in these Appendices, there are a few cases in which it seems that the inoculum responsible for the initial attack at some of the stations came down with rain.

(xii) Spore showers following 'relevant' winds

As stated in Part Two, heavy spore showers of black rust have been recorded in Canada and U.S.A. As many as 266 uredospores were caught on one stationary slide over Manitoba two weeks before rust appearance. In U.S.A. 800 uredospores were recorded per square inch at the level of the growing plants in southern Minnesota during a strong southerly wind and in advance of local rust development. Buller [1939] referred to clouds of uredospores which are carried by winds for hundreds of miles to western Canada from the middle-western parts of U.S.A.

In this country heavy spore showers, at any rate in the earlier part of the season, are rare probably because of the fact that with the exception of a few valleys in the interior of the Himalayas wheat and barley are cultivated in the hills on small terraces. Besides, the acreage under these crops in the hills is very small, i.e. hardly 5 per cent of the total area.

All the same, light spore showers are fairly frequent as is clear from the Tables of aeroscope-slides appended to Parts Two, Three and Four. During these studies four slides showed 100 spores or more and only once were over 500 caught on a single slide 4 to 2 weeks before rust appearance.

(xiii) Spore showers without 'relevant' or 'possibly relevant' winds

Such cases have been dealt with already and although it is difficult to explain them fully, it seems probable that the inoculum came with winds from places of earlier rust appearance regarding which no information was available about the dates of outbreaks.

It is equally likely that in some cases winds laden with spores arrived at the stations under study during the intervals between daily meteorological observations. Further, at stations which are not far away from hilly areas, where oversummering takes place although only occasionally, the inoculum might have come down as a result of local wind disturbances, not covering large tracts of the country.

The rôle of katabatic winds as carriers of inoculum to foot-hills has already been discussed. Such inoculum as comes down with katabatic winds, from day to day, may be carried by local winds to plains near the foot-hills and no 'relevant' winds may, therefore, be found for those stations.

(*xiv*) *Rust outbreaks before which no spores were detected on aeroscope-slides*

Reference to such outbreaks has already been made in Part Two. The absence of spores from aeroscope-slides may be due to spore showers being very light, and the small amount of air that may pass through the box of an aeroscope cannot be regarded as representative of the huge volume of air that covers the fields. Further, if there is no disturbance in the air at ground level when spores are alighting on the crop no spores may be caught on the slide in the aeroscope. Only one aeroscope was exposed at each station with the exception of Poona where exposures were made during 1933 to 1938 in a second aeroscope. Reference may here be made to the aeroscopes exposed on the tower of the Poona Observatory (120 ft. above ground) and at the College farm, Poona (Table II). While no spores were caught on slides exposed on December 4 to 7 and 7 to 11, 1935 at the Observatory, the slide exposed at the farm on December 5 to 9 showed four spores.

In this connection, it is necessary to refer again to the rôle of rain in bringing down spores from the upper-air although none may be caught on aeroscope-slides.

(*xv*) *Delayed outbreaks of rusts*

In examining the data several cases were noticed where rust appeared after considerable delay, sometimes as long as 8-9 weeks from the last date of the first spore shower whereas the maximum length of the incubation period for any of the three rusts does not normally exceed 14 days in the plains of this country. Excepting Peninsular India where the range of temperature seems to be too high for the development of yellow rust, as shown by its absence from year to year, weather conditions during the greater part of winter in the plains are favourable for black and brown rusts, and in the north and central parts of the country for yellow rust as well.

It is evident, therefore, that rusts will appear in the plains of India, in general, within 14 days from the date of uredospores alighting on the crop unless their germination is delayed on account of dry weather, i.e. low humidity and absence of rain or dew from day to day.

Some of the instances where the appearance of rust had been delayed by 1 to 7 weeks were selected at random, and data of rainfall, range of humidity as well as its weekly average were collected for the entire period following the first spore shower. Details are supplied in Appendix H separately for each rust, and the dates of subsequent spore showers, if any, up to the commencement of the incubation period are also shown.

It is clear from this appendix that only in four cases out of thirteen did the first rain occur just before the commencement of the incubation period in relation to the dates of rust appearance.

The first instance is that of black rust at Agra [1932-33] in which there was a delay of approximately seven weeks from the last date of the first spore shower, rust appearing nearly nine weeks after that date. No rain occurred during the first seven weeks and there was also a spore shower 18 to 14 days before the date of rust appearance. It may also be pointed out that the highest average humidity during the first seven weeks was only 73 per cent although it rose to a maximum of 100 per cent on two days during that period.

In the second case, i.e. of brown rust at Lyallpur [1934-35], there was delay of only one week. No rain fell till the 13th day before rust appearance but the average humidity on the other hand was higher in the first week than during the fortnight following.

The third example is that of yellow rust at Jubbulpore [1934-35] in which rust appeared after a delay of two weeks. There was no rain for nearly a week after the first spore shower but it fell twice during the next week and there was rain also a fortnight before the date of rust appearance. Two spore showers occurred just before the commencement of the incubation period.

In the fourth instance, i.e. of yellow rust at Gorakhpur [1932-33], there was a delay of six weeks. No rain fell till the end of the sixth week and during that week the average humidity also happened to be highest. The last spore shower occurred nearly a month before the date of rust appearance.

In the remaining nine instances delay in rust appearance is more difficult to explain because in four of them there was rain just before the commencement of the incubation period as well as 1 to 4 weeks earlier. The examples referred to are those of black rust at Agra [1930-31] and of black, brown and yellow rusts at DehraDun [1937-38]. In three other instances there was no rain just before the commencement of the incubation period and in the remaining two no rain fell after the first spore shower and up to the beginning of the usual period of incubation.

While it is not possible to draw any general conclusion from these data, some cases of delay in rust appearance may be due to bright sun soon after the rain, as a result of which the film of water dried up before the spores could germinate and infect the host.

Again, no general statement can be made regarding delay in rust appearance owing to low humidity. It is clear from the data given in Appendix H that whereas in some of the cases the range of humidity during the period following the first spore shower was fairly low it was not so in others.

While dealing with the relation of weather to the development of stem-rust in the Mississippi valley, Lampbert [1929] concluded that no evidence was available of any specific meteorological conditions or set of conditions that always accompany epidemics. The same author observed that severe epidemics sometimes develop in parts of the Red River Valley in which rainfall is totally absent. It is suggested that heavy dew may account for this condition.

Heavy dew does occur off and on in the plains of India during winter and it is quite likely, therefore, that in several cases spores alighting on the crop from time to time may germinate because of dew and cause infection even in the absence of rain.

(xvi) Winds of the first three heights traced back to hills

During these studies several instances were noticed where winds at 1,640, 3,280 and 4,920 ft. above sea level were traced back to hills with considerably higher altitudes. Although it is not unlikely that winds from 5,000 to 7,000 ft. may come down to any of the heights mentioned above if there be a regular slope, the matter was referred to the Superintending Meteorologist, Upper-Air Observatory, Agra and the Agricultural Meteorologist, Poona, as the writer was in doubt regarding continuity in the flow of such winds. As interpreted by them, it is better not to stretch the extrapolations much beyond the last sub-montane station for which pilot balloon data are available. Such winds should,

therefore, be regarded as having started from the foot-hills. At these localities there should be a fair amount of inoculum in the air due to katabatic winds in addition to that settling down from higher winds from the hills.

(xvii) Relative significance of winds of different heights

The total number of 'relevant' and 'possibly relevant' winds of different heights, including those followed by spore showers, have been shown station-wise for each rust in Tables VII, XV and XXIII respectively. Comparative statements of the total number of such winds at different heights for all the stations taken together are given in Tables XXVI to XXVIII.

Irrespective of the source of inoculum and considering only the rate of fall of spores, the highest percentage of significance from amongst the 'relevant' winds should be found for height A, i.e. 1,640 ft. above sea level and theoretically speaking this percentage should fall proportionately with the height of winds. The same should apply to winds regarded as 'possibly relevant'.

The above interpretation may not, however, hold good for winds of the third height, i.e. nearly 5,000 ft. above sea level, direct from the hills from where abundance of inoculum of black and brown rusts is likely to be disseminated owing to early rust outbreaks on the normal crops and particularly on crops, if any, sown earlier than usual. Winds from altitudes of nearly 7,000 ft., i.e. nearest to the fourth height under reference, are of special importance for the dissemination of yellow rust which breaks out earlier on the new crops at comparatively high altitudes than the other two rusts. The chief test, as far as the writer can see, would be the occurrence of spore showers within the probable period by which spores should reach ground level.

It is necessary to point out the difficulty of attributing spore showers to a 'relevant' or 'possibly relevant' wind of one particular height or the other when spore showers happen to be continuous. For instance, at Jubbulpore there were 13 'relevant' winds for black rust at different heights in 1934-35 but continuous spore showers took place right up to the commencement of the incubation period. Continuous spore showers were also found at Dharwar in 1935-36, when there were as many as 40 'relevant' winds at different heights during the period for which trajectories were studied. Similarly, for brown rust there were 46 'relevant' winds at different heights at Sabour in 1934-35 and spore showers occurred continuously during the period for which trajectories were studied.

In the absence of information regarding rust outbreaks from a large number of stations the possibility of the dissemination of inoculum from some of them cannot be altogether precluded. Obviously, winds coming from or passing over stations from which information regarding earlier rust outbreaks was not available could not be regarded as 'relevant'. It is not possible, therefore, to state that the spore showers recorded in the various Tables took place only in relation to the winds interpreted as 'relevant' or 'possibly relevant'. Besides, it is equally likely that some of the spore showers might have been caused by winds that blew during the intervals between daily meteorological observations.

The number of winds followed by spore showers may not therefore be strictly in accordance with the obvious interpretation that winds of heights A, *i.e.*, 1,640 feet, should show the highest percentage of significance. Further, it is likely that some of the spore showers attributed to higher winds might have really been caused by the inoculum brought down by winds at a lower level that blew during the intervals between the daily meteorological observations.

It is clear from Table XXVI that for black rust none of the winds at 8,200 feet was 'relevant'. No spore shower could be detected in relation to any of the 'relevant' winds at 9,840 feet alone but on five occasions spore showers occurred when winds were blowing simultaneously or at short intervals at one or more lower heights as well. The only 'relevant' wind at 13,120 feet was not followed by a spore shower. With regard to observations of clouds at 9,840 feet it may be mentioned that on eight days out of sixteen in 1933-34 and twenty-one in 1935-36 clouds were found to be moving from the Nilgiris to Mandya; spore showers were detected in relation to six of them in 1935-36, three for that height alone and the other 3 along with winds at lower heights. In view of the fact that Mandya is situated near the foot of the Nilgiris, it is not possible to state that spore showers in relation to winds at 9,840 feet alone were definitely caused by them as there would be a fair amount of inoculum in the air at different heights brought down by katabatic winds also from the Nilgiris. Besides, it is unlikely that spores from winds at 9,840 feet from the Nilgiris would settle down at Mandya, which is only 128 miles from Ootacamund and less than 100 miles from the base of those hills.

For brown rust, as shown in Table XXVII, there was no 'relevant' wind at 9,840 feet but one spore shower was detected in relation to a wind to Mandya based on cloud observations for that height alone, and the explanation given above applies to this also.

No comments are necessary on Table XXVIII for yellow rust.

To sum up, it may be stated that in view of the difficulties pointed out above no definite conclusions can be drawn with regard to the relative significance of winds at each of the specified heights alone.

(xviii). Significance of 'relevant' and 'possibly relevant' winds from the statistical standpoint

From the nature of this study, it is clear that for purposes of statistical comparison, little importance can be attached to winds which passed over stations where rusts appeared later than the dates of the winds concerned. The same applies to such winds as came from or passed over stations wherefrom no information was available regarding the dates of appearance or absence of rusts. The number of 'relevant' and 'possibly relevant' winds, therefore, may not show any relationship to the total number of winds studied. Scrutiny from the statistical standpoint should, consequently, apply only to such winds as were traceable from or passed over a station or stations of known earlier appearance of rust. It would also apply to winds that came from hills where rusts had been observed repeatedly to oversummer or to break out very early in the season due to earlier sowings but about which no definite information regarding the date of rust appearance was available for a particular year. As explained in Part One, such winds have been called 'relevant' and 'possibly relevant' respectively. All these winds were carefully scrutinized to see which of them were followed by spore showers prior to the commencement of the incubation period and in relation to the dates of rust appearance.

The writer is conscious of the need of scrutiny of 'non-relevant' winds, numbering, 3,942, 2,430 and 2,091 respectively for black, brown, and yellow rusts, in relation to spore showers but this scrutiny would have served no useful purpose unless one could be sure that the rust concerned had not appeared earlier at *any* of the stations passed over by such winds. As it is, no information was available from a large number of stations passed over by such winds, either about the date of appearance of the rust concerned or even its absence.

However, all records of rust appearance at the stations under study for which there was no 'relevant' wind in one or more years but at which spore showers occurred well before rust appearance, as shown in tables VI, XIV and XXII, were again scrutinized to make sure if some of the so-called 'non-relevant' winds came to those stations from the hills and which might, therefore, be interpreted as 'possibly relevant'. While in some cases such winds were found, in others there was no indication as to where the inoculum came from but, as mentioned above, for want of information from intermediate stations it would not be correct to state that the rust concerned had not appeared *anywhere* earlier than the dates of those winds. Some of these records are described in the text and a few have also been represented on maps dealing with winds which could not be interpreted as 'relevant'. A summarized account of such records has also been given in Tables VIII, XVI and XXIV for black, brown and yellow rusts respectively.

It is not possible to state, even approximately, the number of 'relevant' and 'possibly relevant' winds for each rust which were followed by spore showers that actually caused the initial outbreaks because the duration of the incubation period is not the same for the three rusts and because it may vary from place to place as well as from month to month according to temperature. The writer [Mehta, 1923], from a study of cultures of wheat rusts grown simultaneously at comparatively low temperatures, concluded that the duration of the incubation period was shortest for yellow and longest for black whereas for brown rust it was intermediate between the other two. Further, the length of the incubation period is not fixed at 8 to 10 days but varies considerably according to temperature.

On the whole, as will be clear from Appendices D and E, black rust should appear in the plains after a shorter incubation period in Peninsular India than in the north. Reference has already been made to the total absence of yellow rust in the plains of Peninsular India but this rust is the commonest in the Punjab where the black rust is not so common as elsewhere. Brown rust is found only occasionally in Peninsular India but is fairly common in the rest of the country. For the purpose of scrutinizing spore showers it is difficult to fix the length of the incubation period in relation to the dates of rust appearance because a cold wave in the south during winter and a spell of warm weather in the north would make such calculations altogether arbitrary. In view of the above considerations, the maximum duration of the incubation period was fixed at 14 days on the basis of inoculation experiments conducted at Agra; such spore showers as occurred only 14 to 10 days before rust appearance have also been shown in Tables VI, XIV and XXII.

The question of the absence of spore showers in some of the records of rust appearance has already been discussed. It must be pointed out that a high percentage of significance in relation to spore showers from amongst the 'relevant' winds could be expected only if such winds started from or passed over one or more stations where the rust had appeared at least 4 to 8 weeks prior to the dates of the winds. Normally, there would have to be several generations of uredo-infection before enough inoculum could ascend to the upper-air for dissemination. In dry weather, however, rust may not spread to a considerable extent locally at some of the stations even within a period of eight weeks from the date of the initial outbreak. Besides, in a country like this, where rusts occur in the plains only for a period of three months or so, it is very difficult to find a sufficient number of stations where infection occurs two months ahead of the dissemination of rust to distant parts of the country. In these studies,

therefore, the minimum period for the relevancy of winds had to be fixed at 15 days after the date of the initial outbreak particularly because, as explained before, the actual dates of rust appearance at several stations might have been earlier than those reported.

Tables VI, XIV and XXII show that out of a total of 88 records of appearance of black rust, 'relevant' winds from stations where this rust had broken out at least four weeks earlier were found in 34. For brown rust out of 59 records such winds were found only in 17 and for yellow rust in 21 records out of 51.

Without prejudice to the observations made above it may be stated that with black rust nearly 53 per cent 'relevant' and 30 per cent 'possibly relevant' winds were followed by spore showers in relation to the dates of rust appearance at all the stations considered collectively. For brown rust 31·5 per cent 'relevant' and 30·5 per cent 'possibly relevant' winds were followed by spore showers, but for yellow rust the percentage of such winds was only 10 and 9 respectively. These figures have been calculated from the data supplied in Tables XXVI-XXVIII. It will be remembered that uredospores of yellow rust are rather difficult to detect on aeroscope-slides exposed some weeks before examination, and this may explain the low percentage of winds followed by spore showers for this rust.

In foot-notes to Tables VII, XV and XXIII additional numbers of 'relevant' and 'possibly relevant' winds have been shown separately for each rust. As explained therein, these winds were followed by spore showers which occurred during the periods not strictly in accordance with their heights and could not therefore be included in Tables XXVI to XXVIII.

A still lower percentage of significance in the case of 'possibly relevant' winds does not call for any explanation in view of the fact that information about the actual dates of initial infection on the new crop was not available from any of the hilly areas except from the neighbourhood of Simla.

The writer feels that the percentage of spore showers caused by 'relevant' winds might have been higher if arrangements could have been made for the exposure of slides in half a dozen aeroscopes in different fields under cultivation at each of the stations under study. This was not possible without additional staff.

(*xix*). *Foci of infection in relation to initial rust outbreaks in the foot-hills and plains, and the prevailing directions of dissemination during the period of study*

While it is not possible after only six years' study to trace the source of initial rust outbreaks for every province and district in a country of the size of India, the data obtained have further corroborated the writer's contention that all hills and hilly tracts with an altitude of about 4,000 feet, where wheat or barley are sown, are potential foci of black rust. Places situated at altitudes slightly higher than that would be sources of inoculum of brown rust as well, and all the three rusts are disseminated from hills with altitudes of about 6,000 feet and above. A focus in the north, *i.e.*, central Nepal, and another in the south, the Nilgiris and Palni hills, need special mention because of earlier sowings and consequently very early dissemination of rusts to the plains. In addition to the normal crop, wheat is sown in central Nepal during August-September and well-advanced infection by all the three rusts has been observed during December, sometimes even in the first week of that month, on the early crop.

At higher altitudes in the Nilgiris and the Palni hills two crops of wheat and barley are raised every year, one sown during April to August and the other during September to November. Consequently there is abundance of rusts on the first crop from August onwards and also on the second during October-November when wheat is sown all over the plains of Peninsular India.

The writer is convinced that dissemination of inoculum rather *early* in the season from these foci to the Indo-Gangetic plain and Peninsular India respectively is chiefly responsible for the devastating epidemics over large tracts of the country.

With regard to the prevailing directions of dissemination these studies have yielded information of great interest which is summarized below. The details have already been supplied in the various Tables, Maps and text of Parts Two, Three and Four:

(*a*) ***Black Rust.***—No initial outbreak of this rust anywhere in the plains or foot-hills of Peninsular India could be connected with any of the 'relevant' winds from the north. This is evidently due to the fact that whereas black rust has occasionally been found to break out by the middle of November at some stations of Peninsular India on the normal crop, and on wheat sown 'out of season' at Coimbatore and Mandya as early as September 10 and October 16 respectively, this rust has never been found to appear anywhere in the Indo-Gangetic plain, Bihar, Bengal, Assam or the central parts of the country before the last week of December. As a matter of fact, over the greater part of these areas black rust usually breaks out during January to March and even in the foot of Nepal range it has not been found before the last week of December.

During the period of these studies there were 53 winds in all from hills in the north to six stations of Peninsular India, but no importance should be attached to them because rust did not appear at any of the intermediate stations till 2-3 months later. It whould not be right, therefore, to regard any of those winds as 'possibly relevant' and for that reason they are not included in Tables VI and VII.

Similarly, there was no 'relevant' wind from the hills of Peninsular India to any of the stations in the north.

On the other hand, there were nine 'relevant' winds from four stations in the plains of Peninsular India to Sind, Bihar, United Provinces and even the Punjab.

For Central Provinces there were 'relevant' winds from the north as well as the south and the same applies to Sind. Some 'relevant' winds from Pottangi (hilly tract of Orissa) and the Western Ghats also blew to the Central Provinces. In the United Provinces the bulk of the inoculum causing initial outbreaks came from central Nepal although some of the attacks appear to have been caused as a result of dissemination from the Siwalik range as well.

There were several 'relevant' winds from central Nepal to stations in Bihar, Bengal and Assam.

For stations in the plains of the Punjab, where this rust appears very late, i.e., during March-April, a fair amount of inoculum seems to have been disseminated from the United Provinces, as suggested by the dates of rust appearance and wind curves for Karnal which is on the border line.

(b) ***Brown Rust.***—No wind from the north was found to be 'relevant' for any station in Peninsular India for this rust either. There were in all six winds from hills of the north for one station of Peninsular India but they were of little importance as this rust broke out at intermediate stations nearly 1-2 months later than the dates of the winds. As stated in Part Three, this rust has been found only occasionally in Peninsular India.

There was no 'relevant' wind for this rust from the Nilgiris, Palni hills or Western Ghats to the north, but there were two such winds, one from Pottangi and the other from Hyderabad (Deccan) to Agra during one of the years of this study. The observations about black rust apply also to brown rust as regards the Central Provinces, United Provinces, Bihar, Bengal and Assam. In addition, there were 'relevant' winds from the Simla hills to Bihar and to one of the stations in the United Provinces. For stations in the plains of the Punjab, the inoculum of this rust came from the neighbouring hills, except once to Karnal and Hoshiarpur from western Nepal and from Benares to Lyallpur in one year.

(c) ***Yellow Rust.***—As stated in Part Four, this rust has not been found to break out at any of the stations in the plains or foot-hills of Peninsular India although spore showers took place at most of them as a result of dissemination, in all probability from the Nilgiris and Palni hills; but no wind was found to have come from these hills to any of the stations in the north.

For the United Provinces there were several 'relevant' winds from central Nepal and the Simla hills. There was one 'relevant' wind to Sakrand (Sind) from the United Provinces. For Jubbulpore (C.P.) the 'relevant' winds came from Nepal, Simla hills, the Punjab and U.P.

'Relevant' winds to stations in Bihar came from different sources, *e.g.*, Nepal, hills and plains of the United Provinces and the Punjab. Stations in the plains of the Punjab received their inoculum from the neighbouring hills, Nepal and the plains of the United Provinces.

To sum up, it may be stated that for initial rust outbreaks in the plains of India the foci in hills of the north as well as the south seem to be circumscribed. Whereas the plains of Peninsular India might function as secondary foci for some of the places in the central parts of the country and even the north, as far as black and brown rusts are concerned, no case of the outbreak of these rusts in Peninsular India could be attributed to inoculum from the north. The question of the dissemination of yellow rust from the plains of Peninsular India to the north and *vice versa* does not arise because it does not occur in the former area.

It would be premature to make any definite statement regarding the distribution of physiologic races of each of the three rusts of wheat in the different hills and hilly tracts of this country or their occurrence in the plains from year to year. The study of physiologic races was started only in the year 1932 and the number of collections analysed, so far, is not large enough to enable one to state that no other race besides those recorded is likely to be found in the hills or the plains. Nevertheless, there are indications of restriction in the distribution of some of the races in the hills as well as the plains of the north and Peninsular India respectively. Detailed information obtained from the study of physiologic races up to the end of March 1938 has been supplied in the previous monograph [Mehta, 1940]. As stated therein, six races of black rust (15, 21,

24, 40, 42 and 75), six of brown (10, 20, 63*, 106*, 107* and 108*) and eight of yellow (13, 19, 20, 31, A*, D*, E* and F*) have been found. Recently, another race of this rust has been met with and it is provisionally called G.

Information regarding the distribution of these races, available at present, is summarized below.

(*a*) Race 21 of black rust has been found only once in the plains of the Punjab but not in any of the hills so far. Race 24 has been met with only in the Siwalik range from amongst the hills and in the plains of Rajputana, Delhi Province and once at Poona and Himayatsagar (Hyderabad-Deccan). The other races, *i.e.*, 15, 40, 42 and 75, are widely distributed, but the last one has not been found in Kashmir, Kumaon, Pottangi area and the Nilgiris.

(*b*) Races 106 and 108 of brown rust have not so far been found in any of the hills of the north although the former was once met with in the Nilgiris. Both these races are rare, having been found only once in the plains of the United Provinces and the Punjab. Races 20 and 63 are widely distributed. The remaining two, *i.e.*, 10 and 107, have not been found in the Western Ghats and Pottangi area. Race 10 is not found in Kashmir. So far, race 107 has not been met with in the plains of Peninsular India.

(*c*) Races 20 and F of yellow rust seem to be restricted to the Nilgiris and 13 to Nilgiris and the Palni hills. Race D has been met with only in the Siwalik range and E in Kashmir alone. Race 31 has been found only in Nepal and the Siwalik range. The other two, *i.e.*, 19 and A, are widely distributed in the hills but the former has not been found in Kashmir and neither of them in the Palnis. Race G has been met with only in the Nilgiris so far.

Races 19, 31 and A have been repeatedly found in the Indo-Gangetic plain and only occasionally in the Central Provinces and Rajputana. Race E is rather rare in the plains and D has not been found even once. None of the eight races has been met with in the Western Ghats and the Pottangi area and the same applies to the plains of Gujerat-Kathiawar, Baroda, Bombay-Deccan, Hyderabad, Mysore and Madras. Yellow rust is not found any where in the south except in the Nilgiris and Palni hills.

(*xx*) *General summary of data*

For convenience of reference a summary of the information supplied in various tables is given below.

A. *Spore showers in relation to rust appearance* (*Study of aeroscope-slides*). *Slides were exposed in aeroscopes at 62 representative stations, the maximum number in any year being 54.*

(*a*) **black rust** (Ref. Table II)

Number of stations where rust appeared	54
Total number of records of rust appearance	219
Number of records in which slides were not exposed 4 to 2 weeks before rust appearance	14
Number of records in which spores were caught 4 to 2 weeks before rust appearance	181

* New race reported by the writer [Mehta, 1940]

Number of records in which spores were caught only 14 to 10 days or so before rust appearance	8
Number of records in which no spores could be detected even 10 days before rust appearance	16*

(*b*) **brown rust** (Ref. Table X)

Number of stations where rust appeared	46
Total number of records of rust appearance	154
Number of records in which slides were not exposed 4 to 2 weeks before rust appearance	5
Number of records in which spores were caught 4 to 2 weeks before rust appearance	97
Number of records in which spores were caught only 14 to 10 days or so before rust appearance	3
Number of records in which no spores could be detected even 10 days before rust appearance	49*

(*c*) **yellow rust** (Ref. Table XVIII)

Number of stations where rust appeared	31
Total number of records of rust appearance	135
Number of records in which slides were not exposed 4 to 2 weeks before rust appearance	3
Number of records in which spores were caught 4 to 2 weeks before rust appearance	64
Number of records in which spores were caught only 14 to 10 days or so before rust appearance	17
Number of records in which no spores could be detected even 10 days before rust appearance	51*

B. *Spore showers in relation to winds as well as dates of rust appearance (Study of wind-trajectories).*

(*a*) **black rust** (Ref. Table VI, wind-trajectories for 23 stations).

Total number of records of rust appearance	88
Number of records in which winds from places of known earlier outbreaks were followed by spore showers	27
Number of records in which wind from localities of oversummering were followed by spore showers	19
Number of records of spore showers 4 to 2 weeks before rust appearance but not in relation to winds under the above two heads	24†
Number of records in which no spores could be detected nearly 4 to 2 weeks before rust appearance	6
Number of records in which spores were caught only 14 to 10 days or so before rust appearance	2

* Such cases have been discussed under sub-head (xiv) of this Part
† Such cases have been discussed under sub-head (xiii) of this Part

Number of records in which slides were not exposed at all ...	6
Number of records in which slides were not exposed 4 to 2 weeks before rust appearance	4

(*b*) **brown rust** (Ref. Table XIV, wind-trajectories for 18 stations).

Total number of records of rust appearance	59
Number of records in which winds from places of known earlier outbreaks were followed by spore showers	19
Number of records in which winds from localities of oversummering were followed by spore showers	13
Number of records of spore showers 4 to 2 weeks before rust appearance but not in relation to winds under the above two heads	6†
Number of records in which no spores could be detected nearly 4 to 2 weeks before rust appearance	17
Number of records in which spores were caught only 14 to 10 days or so before rust appearance	2
Number of records in which slides were not exposed ...	2

(*c*) **yellow rust** (Ref. Table XXII, wind-trajectories for 13 stations).

Total number of records of rust appearance	51
Number of records in which winds from places of known earlier outbreaks were followed by spore showers	5
Number of records in which winds from localities of oversummering were followed by spore showers	13
Number of records of spore showers 4 to 2 weeks before rust appearance but not in relation to winds under the above two heads	8†
Number of records in which no spores could be detected 4 to 2 weeks before rust appearance	18
Number of records in which spores were caught only 14 to 10 days or so before rust appearance	5
Number of records in which slides were not exposed ...	2

C. ***Significance of 'relevant' winds, i.e., from places of known earlier outbreaks of rusts.*

(*a*) **black rust** (Ref. Tables VII and XXVI).

Total number of winds	378
Number of winds followed by spore showers	181‡
Number of winds for which no spore showers could be detected as slides were not exposed	30
Number of winds which were not followed by spore showers ...	121

† Such cases have been discussed under sub-head (xiii) of this Part
** Further details of records of rust appearance already described under B
‡ As explained in foot-note to Table VII, spore showers also occurred in relation to 41 other 'relevant' winds

(*b*) **brown rust** (Ref. Tables XV and XXVII).

Total number of winds	334
Number of winds followed by spore showers	101‡
Number of winds for which no spore showers could be studied as slides were not exposed	18
Number of winds which were not followed by spore showers ...	168

(*c*) **yellow rust** (Ref. Tables XXIII and XXVIII).

Total number of winds	217
Number of winds followed by spore showers	21†
Number of winds for which no spore showers could be studied as slides were not exposed	0
Number of winds which were not followed by spore showers ...	186

D. ***Significance of 'possibly relevant' winds, i.e., from localities of over-summering.*

(*a*) **black rust** (Ref. Tables VII and XXVI).

Total number of winds	651
Number of winds followed by spore showers	190‡‡
Number of winds for which no spore showers could be studied as slides were not exposed	24
Number of winds which were not followed by spore showers ...	324

(*b*) **brown rust** (Ref. Tables XV and XXVII).

Total number of winds	648
Number of winds followed by spore showers	195*
Number of winds for which no spore showers could be studied as slides were not exposed	8
Number of winds which were not followed by spore showers ...	354

(*c*) **yellow rust** (Ref. Tables XXIII and XXVIII).

Total number of winds	669
Number of winds followed by spore showers	56⋇
Number of winds for which no spore showers could be studied as slides were not exposed	46
Number of winds which were not followed by spore showers ...	493

** Further details of records of rust appearance already described under B

‡ As explained in foot-note to Table XV, spore showers also occurred in relation to 52 other 'relevant' winds

† As explained in foot-note to Table XXIII, spore showers also occurred in relation to 10 other 'relevant' winds

‡‡ As explained in foot-note to Table VII, spore showers also occurred in relation to 113 other 'possibly relevant' winds

* As explained in foot-note to Table XV, spore showers also occurred in relation to 91 other 'possibly relevant' winds

⋇ As explained in foot-note to Table XXIII, spore showers also occurred in relation to 74 other 'possibly relevant' winds

(xxi). Conclusions

(*a*) In view of the absence of a local source of infection at the time of sowing wheat and barley and the very much delayed appearance of rusts in the plains of India, notwithstanding favourable weather, one may safely conclude that the inoculum is re-introduced there from some other source.

(*b*) There is little likelihood of the dissemination of rusts to India from across the seas nor is there any evidence of the inoculum coming from adjacent countries, except Nepal, prior to initial outbreaks in the plains.

(*c*) All the three rusts of wheat, two of which also attack barley, have repeatedly been found to oversummer in the uredostage at various altitudes in hills within the country itself.

(*d*) Uredospores of wheat rusts have been caught at several heights in the air up to 10,700 feet above sea level. This shows the importance of the rôle of upper-air currents in the dissemination of cereal rusts over long distances.

(*e*) Daily katabatic winds also play an important part in bringing down rust inoculum from the hills to the foot-hills and plains in the neighbourhood.

(*f*) In general, single spores of each of the three rusts of wheat should settle down in still air at the rate of about 130 to 150 feet per hour. Spores in clusters and those adhering to dust particles fall at a faster rate.

Without prejudice to some of the misfits, referred to in different Parts of this Section, which are difficult to explain, it may be observed that:

(*g*) As revealed by the study of aeroscope-slides uredospores of black and brown rusts were often caught at a large number of stations 4 to 2 weeks before the dates of their appearance on the local wheat crop. Uredospores of yellow rust were caught far less frequently.

(*h*) The circumstantial evidence of rust dissemination by wind, obtained from the study of wind-trajectories, is fairly strong. This is clear from the number of records in which 'relevant' and 'possibly relevant' winds were followed by spore showers in relation to the total number of records of the appearance of black and brown rusts. For yellow rust, however, the number of such winds was much smaller. This has been explained in the text under sub-head (xviii) of Part Five.

(*i*) No definite conclusions could be drawn regarding the relative significance of winds which blew at each of the four specified heights for which wind-trajectories were prepared and studied.

(*j*) From the statistical standpoint the percentage of significance in the case of 'relevant' winds in relation to spore showers for black and brown rusts was fairly high. For yellow rust the percentage was rather low and this has also been explained under sub-head (xviii) of Part Five.

(*k*) Irrespective of the source of winds that brought the inoculum, most of the records of rust appearance could be attributed to spore showers that occurred 4 to 2 weeks or 14 to 10 days prior to local outbreaks at the observation stations.

(*l*) All hills with an altitude of about 6,000 feet and above may act as foci of infection for each of the three rusts. Brown and black rusts may also be disseminated, at least occasionally, from altitudes of 4,000 feet or so. Details of the physiologic race flora of the various hills so far available are a further proof of the re-introduction of rusts into the plains each year from those areas.

(*m*) As far as initial outbreaks of rusts in the plains are concerned the foc in the north and the south seem to be circumscribed.

(*n*) By far the most important foci for the dissemination of rust inoculun lie in central Nepal, the Nilgiris and Palni hills, owing to early crops being growi there. It is the *early* dissemination from these hills to the Indo-Gangetic plaii and Peninsular India, respectively, that is chiefly responsible for devastatin; epidemics over large tracts of the country.

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TABLE XXVI

Comparative statement of the total number of Relevant and Possibly Relevant winds at different heights as shown in Table VII—Black Rust

(1) Height of winds in feet above sea level	(2) Full Number of winds studied for each height	(3) Relevant Winds: Total number Ref. Table VII (a)	(3) Relevant Winds: Number followed by spore showers as detailed under (a) and (b)	(3) Relevant Winds: Number followed by spore showers for specified height only as shown in Col. 1 (a)	(3) Relevant Winds: Number followed by spore showers relating to winds at other heights also (b)	(4) Possibly Relevant Winds: Total number Ref. Table VII (i)—(iv)	(4) Possibly Relevant Winds: Number followed by spore showers as detailed under (a) and (b)	(4) Possibly Relevant Winds: Number followed by spore showers for specified height only as shown in Col. 1 (a)	(4) Possibly Relevant Winds: Number followed by spore showers relating to winds at other heights also (b)
1,640	840	77 (2)*	36	16	20	232 (3)*	78	23	55
3,280	1,349	92 (3)*	41	3	38	186 (5)*	51	7	44
4,920	1,341	95 (12)*	51	12	39	120 (6)*	30	0	30
6,560	1,307	93 (13)*	41	7	34	113 (10)*	31	5	26
8,200	32	0	...	...	...	0	...	...	...
9,840	87	6	5	0	5	0	...	...	...
9,840	8—	8	6	3	3	0	...	...	...
13,120	1†	1	0	...	...	0	...	...	...
13,120	1‡	1	1	0	1	0	...	...	...
Total ...	4,966	373 (30)*	181U	41	140	651 (24)*	190U	35	155

Out of 23 stations, trajectories for 1,640 feet above sea level were prepared only for 15 as others are situated above that height and some of the winds at each height were untraceable, hence the difference in the number of winds studied. Trajectories for 8,200 and 9,840 feet were prepared for 2 and 6 stations respectively and for one year only

* As shown in Tables VI and VII, no slides were exposed at 4 stations and at 4 others slides were not exposed during a part of the period of wind-trajectories. In addition, some slides got broken in transit and could not, therefore, be examined. In those cases, evidently, no information could be obtained regarding the occurrence or absence of spore showers in relation to 'relevant' or 'possibly relevant' winds. The number of such 'relevant' and 'possibly relevant' winds has been shown height-wise (in the respective columns in brackets) and should, therefore, be subtracted from the total number in each case

— Trajectories based on cloud observations in the Nilgiris for Mandya during specified periods of 16 and 21 days in 1933-34 and 1935-36 respectively. On other days there were no clouds in that direction

† Trajectory of a wind found coming from the Nilgiris to Mandya during a period of 16 days in 1933-34

‡ Trajectory based on cloud observations in the Nilgiris for Mandya during a specified period of 21 days in 1935-36

U As explained in foot-note to Table VII, spore showers also took place in relation to 41 and 113 'relevant' and 'possibly relevant' winds respectively, which are not included in these numbers. These winds have been shown station-wise in Table VI and marked with a query

Table XXVII

Comparative statement of the total number of Relevant and Possibly Relevant winds at different heights as shown in Table XV—**Brown Rust**

(1)	(2)	(3) Relevant Winds				(4) Possibly Relevant Winds			
Height of winds in feet above sea level	Full Number of winds studied for each height	Total number Ref. Table XV (*a*)	Number followed by spore showers as detailed under (*a*) and (*b*)	Number followed by spore showers for specified height only as shown in Col. 1	Number followed by spore showers relating to winds at other heights also	Total number Ref. Table XV (*i*)—(*iv*)	Number followed by spore showers as detailed under (*a*) and (*b*)	Number followed by spore showers for specified height only as shown in Col. 1	Number followed by spore showers relating to winds at other heights also
				(*a*)	(*b*)			(*a*)	(*b*)
1,640	762	112 (2)*	33	12	21	191 (1)*	49	13	36
3,280	858	76 (1)*	24	5	19	173 (3)*	50	1	49
4,920	881	71 (6)*	22	2	20	145 (1)*	51	3	48
6,560	873	67 (4)*	21	5	16	139 (3)*	45	6	39
9,840	30	0	...	...	...	...	...	...	...
9,840	7—	7	1	1	0	...	...	...	...
13,120	1—	1	0	...	...	...	...	...	...
Total ...	3,412	334 (13)*	101U	25	76	648 (8)*	195U	23	172

Out of 18 stations, trajectories for 1,640 feet above sea level were prepared only for 14 as others are situated above that height and some of the winds at each height were untraceable, hence the difference in the number of winds studied. Trajectories for 9,840 feet above sea level were prepared only for 2 stations for one year

* As shown in Tables XIV and XV, no slides were exposed at 2 stations and at 2 others slides were not exposed during a part of the period of wind-trajectories. In addition, some slides got broken in transit and could not, therefore, be examined. In those cases, evidently, no information could be obtained regarding the occurrence or absence of spore showers in relation to 'relevant' or 'possibly relevant' winds. The number of such 'relevant' and 'possibly relevant' winds has been shown height-wise (in the respective columns in brackets) and should, therefore, be subtracted from the total number in each case

— Trajectories based on cloud observations in the Nilgiris for Mandya during a specified period of 21 days in 1935-36

U As explained in foot-note to Table XV, spore showers also took place in relation to 52 and 91 'relevant' and 'possibly relevant' winds respectively which are not included in these numbers. These winds have been shown station-wise in Table XIV and marked with a query

Table XXVIII

Comparative statement of the total number of Relevant and Possibly Relevant winds at different heights as shown in Table XXIII—Yellow Rust

(1)	(2)	(3) Relevant Winds				(4) Possibly Relevant Winds			
Height of winds in feet above sea level	Full Number of winds studied for each height	Total number Ref. Table XXIII (*a*)	Number followed by spore showers as detailed under (*a*) and (*b*)	Number followed by spore showers for specified height only as shown in Col. 1 (*a*)	Number followed by spore showers relating to winds at other heights also (*b*)	Total number Ref. Table XXIII (*i*)—(*iii*)	Number followed by spore showers as detailed under (*a*) and (*b*)	Number followed by spore showers for specified height only as shown in Col. 1 (*a*)	Number followed by spore showers relating to winds at other heights also (*b*)
1,640	681	71 (0)*	4	2	2	191 (14)*	15	4	11
3,280	761	51 (0)*	6	3	3	182 (14)*	16	4	12
4,920	766	46 (0)*	3	0	3	154 (10)*	14	0	14
6,560	769	49 (0)*	8	3	5	142 (8)*	11	3	8
Total ...	2,977	217 (0)*	21U	8	13	669 (46)*	56U	11	45

Out of 13 stations, trajectories for 1,640 feet above sea level were prepared only for 12 stations as one of them is situated above that height and some of the winds at each height were untraceable, hence the difference, in the number of winds studied

* As shown in Tables XXII and XXIII, no slides were exposed at two stations and at one other slides were not exposed during a part of the period of wind-trajectories. In addition, some slides got broken in transit and could not, therefore, be examined. In those cases, evidently, no information could be obtained regarding the occurrence or absence of spore showers in relation to 'possibly relevant' winds. The number of such winds has been shown height-wise (in the respective columns in brackets) and should, therefore, be subtracted from the total number in each case. There were no 'relevant' winds for either of the stations mentioned above or during the periods when slides were not exposed at the third station

U As explained in foot-note to Table XXIII, spore showers also took place in relation to 10 and 74 'relevant' and 'possibly relevant' winds respectively which are not included in these numbers. These winds have been shown station-wise in Table XXII and marked with a query

SUMMARY

PART ONE

A monograph dealing with Physiologic Races, the Rôle of Alternate Hosts and Oversummering in relation to the Annual Recurrence of Rusts of wheat and barley in India was published by the writer in 1940. The present monograph has been written in continuation of the above and supplies a detailed account of the Study of Rust Dissemination carried out during 1932 to 1938 with the help of stationary slides exposed in aeroscopes, slides sent up on kites and balloons and wind-trajectories. Information obtained from the study of slides exposed on aeroplanes in 1931-32 and 1939-40 has also been given. Some other data obtained before 1933 are included.

The scope of the study and the methods employed have been described in detail.

PART TWO

An account of the study of stationary slides exposed in aeroscopes at a large number of stations has been supplied in a detailed table. Information is given regarding the earliest spore showers and those that occurred 4 to 2 weeks or about 14 to 10 days only before the appearance of black rust on the local crops. Dates of rust appearance at each station and information regarding the incidence of black rust, where available, are given in the same table. Details of the study of balloon and kite-slides have also been supplied. Data obtained from these studies show that spore showers took place at most of the stations well in advance of local outbreaks of black rust.

Detailed information based on the study and scrutiny of 4,966 wind-trajectories for 1,640, 3,280, 4,920, 6,560 and in some cases 8,200, 9,840 and 13,120 feet above sea level has been supplied with the help of several tables showing the total number of 'relevant' and 'possibly relevant' winds from different sources. By way of illustration, representative wind-trajectories have been reproduced on 45 maps showing the course of the winds. The relative significance of winds of different heights has also been shown in a table. Data obtained from this study show that at several stations winds came from places where black rust had appeared 15 days to more than two months earlier. Some of these winds were followed by spore showers which occurred 4 to 2 weeks before the date of rust appearance on the local crops. At the same time, no 'relevant' winds were found in the case of several stations.

Some of the records where spore showers occurred 4 to 2 weeks before rust appearance although none of the winds could be regarded as 'relevant' have been discussed and represented on 8 maps.

The various aspects of the study of rust dissemination have been fully discussed with special reference to (*i*) Dates of rust appearance in relation to spore showers, (*ii*) Spore showers in relation to winds, (*iii*) Early rust appearance in the plains due to early crops in and nearness to hills and (*iv*) The probable foci of infection.

Some of the more common misfits have also been discussed and possible explanations offered.

PART THREE

Detailed information has been supplied about brown rust as for black rust in Part Two. Spore showers occurred at most of the stations well in advance of local outbreaks of brown rust on the wheat crop.

During 1932 to 1938, 3,412 wind-trajectories were studied in connection with the dissemination of brown rust of wheat to several stations.

The significance of winds was carefully scrutinized in relation to the dates of spore showers and of rust appearance at these stations. Representative trajectories have been reproduced on 35 maps. Five maps have also been appended with information, by way of comparison, regarding some of the records in which spore showers occurred 4 to 2 weeks before rust appearance although no winds could be regarded as 'relevant'.

PART FOUR

Information has been given about the dissemination of yellow rust on the same lines as for black and brown rusts.

Since 1932, 2,977 wind-trajectories have been studied in connection with the dissemination of this rust.

From the plains of Peninsular India this rust has been constantly absent, probably on account of warmer weather.

Twenty-four maps of 'relevant' winds have been appended. In addition, five maps have been supplied, by way of comparison, for records in which spore showers took place 4 to 2 weeks before local outbreaks but no wind could be interpreted as 'relevant' in relation to places of earlier appearance of the rust.

PART FIVE

In this part, the different aspects of the study of rust dissemination have been discussed at length and wherever possible conclusions applicable to all the three rusts have been drawn. Some of the more important topics discussed are as follows :

Sources of inoculum, the Rôle of upper-air currents, the Rôle of katabatic winds, Rate of fall of spores, Fall of spores with rain drops, Spores howers following 'relevant' and 'possibly relevant' winds, Rust outbreaks before which no spores were detected, Relative significance of winds of different heights, Delayed rust outbreaks and Significance of 'relevant' and 'possibly relevant' winds from the statistical standpoint.

As far as initial outbreaks of rusts in the plains are concerned the foci in the north and the south seem to be circumscribed.

By far the most important foci for the dissemination of rust inoculum lie in central Nepal, the Nilgiris and Palni hills owing to early crops being grown there. It is the *early* dissemination from these hills to the Indo-Gangetic plain and Peninsular India respectively, that is chiefly responsible for devastating epidemics over large tracts of the country.

APPENDIX A*

A NOTE ON AN APPARATUS FOR CATCHING SPORES FROM THE UPPER AIR**

BY

G. CHATTERJEE

Meteorologist, Upper Air Observatory, Agra

(Received for publication on 12 February, 1931)

(With Plates XVII and XVIII)***

The apparatus (Plate XVII) consists of a cylindrical slide-holder H made of brass whose open ends P and Q can be closed by two circular flaps L_1, L_2, hinged about the line XY. The flaps are held in the position shown in the sketch, uncovering the ends of the slide-holder, by means of a thread T working against the tension of the rubber band R. The arrangement is such that when this thread is burnt or cut. the discs fly back under the tension of the rubber band to cover the ends of the slide-holder and are locked in position by a spring catch C.

The slide-holder is attached to the diametral stick (K) of a bamboo cage such that its length is parallel to the diametral stick and the cage is attached to a balloon with this stick vertical. (See E, Plate XVIII). During the ascent of the balloon the slide is thus exposed to a draught of wind.

The thread T whiich holds the flaps from covering the ends of the slide-holder passes through a fuse† F_1, F_2 whose rate of burning is approximately known, the length of this fuse F_1, F_2 is so adjusted that if it is ignited at the end of F_1 just before the balloon is let off, it burns the thread shortly before the balloon has reached the height up to which the slide is required to be exposed. This adjustment is possible because the approximate rate of ascent of the balloon with its attachments is easily calculable.

A string N carrying a paper flag G at its end is attached to the thread T at the point T_1 by means of a wire looped at both ends (W_1 W_2). When the fuse burns the thread this flag is released. The distance between the mouth of the balloon (M in Plate XVIII) and the paper flag (G in Plate XVIII) is adjusted to a definite length, and gives us a bseline on which angular measurements can be taken. The balloon is followed by means of a theodolite, and readings of (1) the angular measure of the baseline on a graticule in the field of view of

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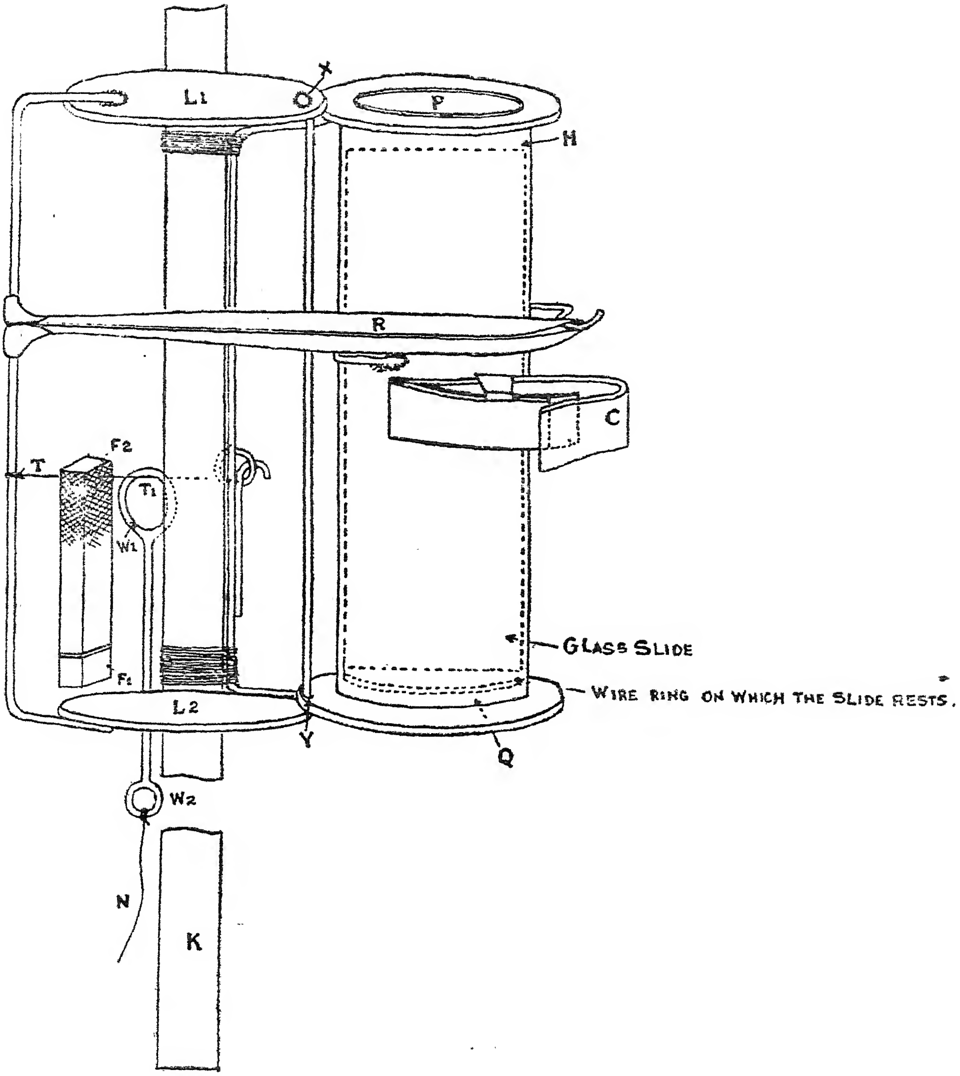
* Reprinted from The Indian Journal of Agricultural Science, Vol. I, Part III, June, 1931

** *This note explains the mechanism of the 'Spore Trap' which was used in hydrogen balloons for the* study of rust dissemination, to which reference was made in the article on 'Annual Outbreaks of Rusts on Wheat and Barley in the Plains of India,' by D. K. C. Mehta, which appears on p. 297 of this Journal

*** In the present text these plates are numbered Plates III and IV respectively

† For a method of preparing the fuse *vide* 'An Upper Air Temperature Indicator for Use with Pilot Balloon', by G. Chatterjee, in *Gerlands Beitrage zur Geophysik* Vol. 24 (1929), p. 351



Mechanism of the 'Spore trap'

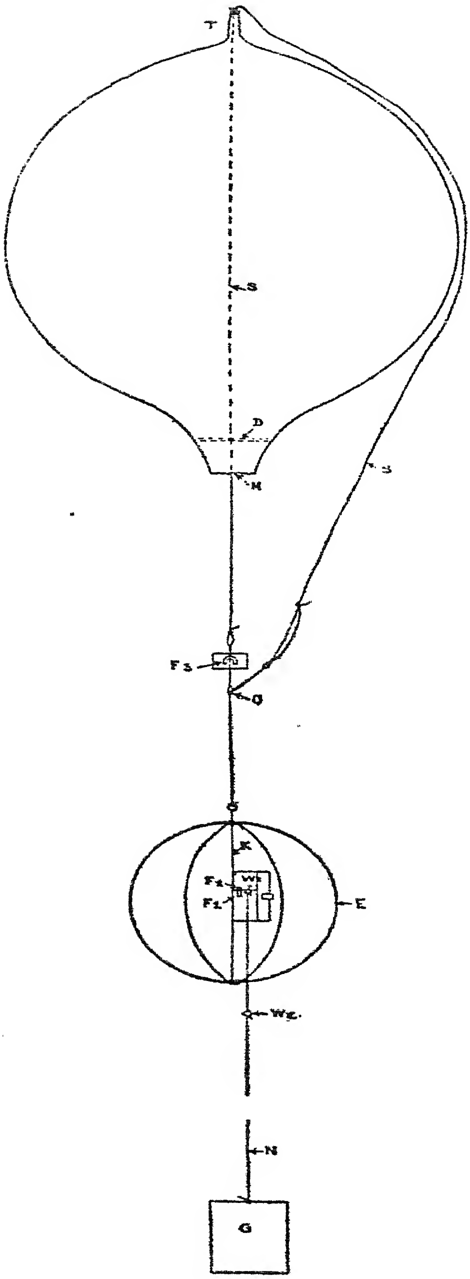


FIG. 1

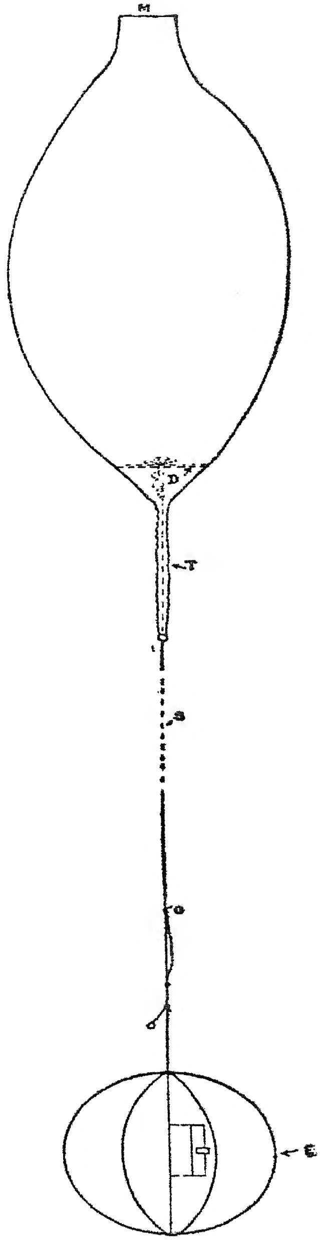


FIG. 2

'Spore trap' attached to the balloon.

the theodolite and (2) angles of azimuth and altitude of the balloon are taken at definite intervals of time. These readings enable one to calculate the height of the balloon above ground at any instant. While following the balloon the instant at which the flag is released is also noted, so that the height through which the slide is exposed to the draught of air is easily calculated. By additional arrangements with an extra fuse it is also possible to begin to expose the slide after a known height above ground is reached.

The aim being to take up the spores-catcher to a desired height and not allow it to drift with the balloon further than is unavoidable, a special type of balloon developed originally by Mr. J. H. Field is used. For this purpose ths balloon after reaching the predetermined height is made to empty itself of its hydrogen gas, with the consequence that the whole system descends under gravity down to the ground. Plate XVIII which gives a picture of the whole system just before ascent (Fig. 1), and during descent (Fig. 2), helps to explain the action of the balloon. Referring to these diagrams one can see that, to start with, the weight of the instrument and the cage is supported by the disc D which serves to close the mouth M of the balloon. The top of the balloon terminates in a long tubular piece T. A string S passes through this tubular piece and connects the top of the disc D with a point O in the balloon tail. Before the balloon is filled with hydrogen the tubular piece is squeezed and crumpled along its length to contract as much as possible, and its top-most end is tied securely to that part of the string S which is near it. Above the point O in the balloon tail is attached a fuse F_3 similar to that used with the spores-catcher but timed for a longer interval.

When the fuse F_3 burns the string above O, the weight of the cage and instrument is transferred to the top of the balloon by means of the string S. The weight of the instrument acting on the tubular piece stretches it, and this in turn acts on the string S and pulls the disc D of the balloon mouth which is now 'up' (*vide* Fig. 2, Plate XVIII). The process results in an escape of hydrogen, collapse of the balloon and downward motion of the whole system. (Fig. 2, Plate XVIII). As the fuse F_1 F_2 attached to the spores-catcher is timed for a smaller interval than the fuse F_3 the former will have worked and the ends of the slide-holder closed before the balloon begins to come down. The slide is thus kept protected from dust, etc., when lying on the ground. A little vaseline spread over the flanges at either end of the slide-holder completely seals the ends for all practical purposes.

A notice promising a reward to the man who brings the balloon to the Observatory is attached to the cage so as to enable a recovery of the instruments sent up. The coming down of the white balloon with the instrument also helps the recovery of the balloon in as much as it helps to attract the attention of the finder.

The balloons used for the purpose are specially made at the Observatory out of Vulpro tissue.*

Upper Air Observatory.
Agra, 6th February, 1931.

* *Vide* Note by the author in *Nature*, Vol. 124, p. 793 1929

APPENDIX B

Study of the dissemination of rusts of wheat and barley under the auspices of the Imperial (now Indian) Council of Agricultural Research.

Instructions for the Exposure of Slides in Aeroscope.

1. The aeroscope has to be screwed down to the board of a wooden stand, about 4 feet above the ground in or near a field under wheat or barley.

2. The board should be perfectly parallel to the ground and its support (a strong wooden post) be firmly dug into the soil. It is of the *utmost importance* that the box of the aeroscope should *move freely* with the wind.

3. The name of the station and the date of exposure should be entered on the label, fixed to each slide, before it is exposed.

4. Each slide has to be smeared with a very thin layer of vaseline and then inserted in the slot, under the sliding cover of the aeroscope and the cover replaced. It is essential that the smeared surface of the slide should face *outwards* in the *direction* of the arrow, painted on the aeroscope and as shown in the figure. (Plate V, fig. 4)

5. The exposure of slides may kindly be started on......................and continued up to...............................

6. Slides have to be changed twice a week (at an interval of 3-4 days) throughout the period mentioned above.

7. After removal from the aeroscope, slides may kindly be kept closed in one of the small boxes provided herewith. When as many as 9 slides have been exposed, they may kindly be returned to the undersigned per unregistered post. *No packing material* except a piece of card-board should be put inside the box, if necessary. Before despatch please make sure that the *slides do not shake*.

8. The date of *first appearance* of each rust* on the local wheat and barley crops may kindly be recorded and communicated to the undersigned, *along with a sample of the rust* as soon as it is observed. Cards† will be supplied to help observers in recognizing the different rusts with the naked eye. Rust samples may kindly be air-dried (spread out on sheets of paper overnight in a room) before despatch.

9. A sample of each rust should also be sent a month later for the study of physiologic races to:

The Senior Assistant,
Rust Research Laboratory,
Simla, E.

10. When not in use, the aeroscope may kindly be kept in a room till needed in the following season.

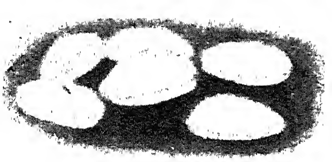
11. The undersigned requests that the above instructions may kindly be observed *carefully*. Special attention is drawn to Nos. 8 and 9.

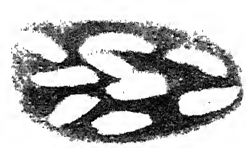
Sd. K. C. MEHTA,
Professor of Botany, Agra College,
Agra (U.P.)

* Black, brown and yellow of wheat and black and yellow of barley

† For the sake of economy, the illustrations on the identification card have not been reproduced here as all the three rusts are shown in Plate III

3





1. A leaf of wheat showing uredo-pustules of yellow rust and some of brown (Actual size).
2. A stem and leaf of wheat infected with black rust (Actual size).
3. An ear of wheat infected with black rust (Actual size).
4. Wheat grains from an healthy plant (X 1½).
5. Wheat grains from a badly diseased plant (X 1½).

APPENDIX C

LIST A

Pilot Balloon Observatories the wind observations of which were utilised for drawing the trajectories for the stations given in List B.

Serial number	Station	Date from which afternoon upper wind observations were available on the charts in addition to the morning observations	Date from which an extra upper wind observation for 0330 a.m. was available in addition to the morning and afternoon observations	Remarks
1	**Agra**	1-3-37	...	
2	**Ahmedabad**	1-3-37	...	
3	**Allahabad**	1-3-37	1-10-36	
4	**Ajmer**	...	...	Closed on 14-10-34
5	**Bahrein**	...	3-9-37	
6	**Bangalore**	20-6-38	...	
*7	**Baitalfalaj**	...	...	Closed on 22-7-35
8	**Begumpet (Hyderabad)** ...	11-6-38 or after	...	
9	**Bellary**	...	...	Closed on 2-9-37
10	**Bhuj**	18-7-38	...	Opened on 14-9-37
11	**Bombay**	1-3-37	1-1-38	
12	**Calcutta**	1-3-37	13-7-36	
13	**Chittagong**	1-3-37	...	
14	**Dacca**	1-6-38	...	
15	**D. I. Khan**	...	...	Closed on 28-1-38
16	**Fortsandaman** ...	28-1-38	...	Opened on 28-1-38
17	**Gaya**	1-6-38	22-3-37	
*18	**Gwadur**	...	2-9-37	Closed on 27-10-38
19	**Jacobabad**	1-3-37	12-7-36	Opened on 1-12-35
*20	**Jiwani**	...	27-10-38	Opened on 27-10-38
21	**Jodhpur**	1-3-37	14-7-36	Opened on 15-10-34

APPENDIX C—*contd.*

Serial number	Station	Date from which afternoon upper wind observations were available on the charts in addition to the morning observations	Date from which an extra upper wind observation for 0330 a.m. was available in addition to the morning and afternoon observations	Remarks
22	**Jubbulpore**	1-3-37	...	
23	**Karachi**	1-3-37	15-7-36	
24	**Lahore**	1-3-37	...	
25	**Madhosagar (Gwalior)** ...	7-5-38	**27-6-38	**As and when required. Opened on 7-5-38
26	**Madras**	1-3-37		
27	**Malegaon**	14-3-39 or after	...	Opened on 8-5-33
28	**Mangalore**			
29	**New Delhi**	1-6-38	23-10-36	
30	**Patna**			Closed on 19-3-37
31	**Peshawar**	1-3-37		
32	**Poona**	1-4-37		Afternoon ascent started on 1-4-37
33	**Port Blair**	1-3-37		
34	**Rajsamand**	23-5-38	**21-6-38	**As and when required. Opened on 20-5-38.
35	**Sambalpur**	1-3-57	...	
36	**Silchar**	...	...	Closed on 31-8-35
*37	**Sharjah**	...	19-12-37	Opened on 22-7-35
38	**Tezpur**	1-3-37	...	
39	**Trichinopoly** ...	1-3-37	...	Opened on 22-6-36
40	**Vizagapatam** ...	1-3-37	...	

*Stations outside India

Sd/- **G. CHATTERJEE,**

Suptdg. Meteorologist.

Upper Air Observatory, Agra

April 6th, 1940

LIST B.

List of stations for which wind-trajectories were prepared for all the four heights

Serial number	Stations	Years for which wind-trajectories were prepared 1932-33	1933-34	1934-35	1935-36	1936-37	1937-38
1	Lyallpur ...						
2	Hoshiarpur						
3	Rawalpindi*						
4	Karnal ...						
5	Sakrand ...						
†6	Delhi ...						
†7	Agra ...						
8	Gorakhpur						
9	Pusa ...						
10	Sabour						
11	Mymensingh						
12	Dhubri						
†13	Jubbulpore	...					
14	Khandwa	x					
15	Pottangi* (Jeypore)	x					
†16	Poona*	...					
17	Dharwar*	...					
18	Parbhani	x	x	x	...	...	...
19	Himayatsagar*	x	...	...	...	...	x
20	Coimbatore	x	...	...	...	...	...
†21	Bangalore*	x	...	x	x	x	x
22	Mandya* (Mysore)	x	...	...	...	...	...
23	Chitaldroog*	...	...	...	...	...	...

*No trajectories were prepared for the first height 1640 ft. in the case of these stations as they are situated above that level.

x Represents the years in which no trajectories were prepared

† Pilot balloon observatories for which actual upper-winds were plotted on the Working Charts

INDIA METEOROLOGICAL DEPARTMENT

Upper Air Observatory.

Dated Agra, the 5th April, 1940.

Out of the stations for which trajectories were prepared the following were pilot balloon observatories for which actual wind observations for the required levels were available:

(1) Agra. (4) Delhi.

(2) Ajmer. (5) Jubbulpore.

(3) Bangalore (6) Patna.

(7) Poona.

(Ajmer and Patna functioned only a part of the period).

For the rest, the direction and velocity of winds over them were extrapolated from the winds of the neighbouring upper air stations.

In drawing the wind-trajectories all the available upper wind observations plotted on the working charts of the Meteorological Office, Poona, were utilised, with due consideration to the general and wind flow the situation of areas of high and low pressures.

In the case of the upper air stations, wind observations were plotted on the working charts from the balloon ascents made in the morning (generally between 6 and 9 a.m.). Besides these morning observations, afternoon wind observations were available for some of the upper air stations for a part of the period and for a few stations an extra observation was also available for 3-30 a.m. in addition to those in the morning and afternoon, for some part of the period.

Sd/- G. CHATTERJEE,

Suptdg. Meteorologist.

APPENDIX D

Weekly range and average maximum and minimum temperatures in degrees Fahrenheit of 12 stations in Baroda, Gujrat-Kathiawar and Peninsular India for the periods of spore showers of Yellow Rust, including a month from the dates of the last spore showers*

Year	Period of spore showers†	Number of slides on which spore showers were detected	Period for which temperature data are given	Weekly range		Weekly average	
				Maximum	Minimum	Maximum	Minimum
			BOMBAY-DECCAN				
			1. Poona				
1933-34	October 9—December 7 ...	3+8‡	October 9—15	85—90	64—73	88.9	69.0
			October 16—22	76—90	58—70	86.7	66.9
			October 23—29	83—90	54—67	88.0	61.4
			October 30—November 5 ...	86—88	52—56	87.6	53.7
			November 6—12	88—93	50—68	88.9	55.0
			November 13—19 ...	84—92	57—68	88.4	64.1
			November 20—26 ...	79—90	62—70	87.1	65.6
			November 27—December 3 ...	86—90	46—66	87.1	52.7
			December 4—10 ...	84—88	48—53	85.9	49.7
			December 11—17 ...	80—85	48—55	82.9	51.0
			December 18—24 ...	73—85	53—67	81.6	63.0
			December 25—31 ...	83—86	48—52	84.0	50.0
			January 1—7	80—85	48—65	83.7	55.3

* Temperature data of 4 stations out of 16 were not available
† Information regarding first spore shower has been given in Table XVIII
‡ Slides exposed at the Poona Observatory

Year	Period of spore showers	Number of slides on which spore showers were detected	Period for which temperature data are given	Weekly range		Weekly average	
				Maximum	Minimum	Maximum	Minimum
			1. Poona—*contd.*				
1937-38	December 7—10	1	December 7—13	81—87	45—65	84.0	53.7
			December 14—20 ...	85—88	52—63	86.6	58.3
			December 21—27	83—88	54—59	86.1	56.4
			December 28—January 3 ...	81—88	53—58	85.7	55.9
			January 4—10	88—92	53—62	89.4	58.0
			2. Niphad (Malegaon)				
1933-34	December 5—January 9 ...	2	December 5—11	85—90	47—51	86.9	49.4
			December 12—18 ...	79—87	45—53	81.6	49.1
			December 19—25	71—88	51—68	82.0	58.9
			December 26—January 1 ...	83—88	47—49	86.6	48.4
			January 2—8	77—88	50—62	82.9	55.1
			January 9—15	69—87	35—58	81.9	47.6
			January 16—22	75—88	35—49	82.4	42.6
			January 23—29	73—93	36—65	85.9	52.0
			January 30—February 5 ...	74—91	35—54	83.3	44.3
			February 6—12	88—95	48—55	91.4	50.3

APPENDIX

Year	Period of spore showers	Number of slides on which spore showers were detected	Period for which temperature data are given	Weekly range		Weekly average	
				Maximum	Minimum	Maximum	Minimum
			2. Niphad (Malegaon)—*contd.*				
1934-35	December 18—January 4 ...	3	December 18—24 ...	86—89	55—63	87.9	58.4
			December 25—31 ...	85—87	53—58	86.1	55.3
			January 1—7	78—87	41—54	83.0	47.1
			January 8—14	81—89	37—63	85.4	52.9
			January 15—21	73—84	33—51	77.9	41.1
			January 22—28	85—92	51—60	88.3	56.3
			January 29—February 4 ...	78—90	45—65	87.7	53.3
			3. Arbhavi (Belgaum)				
1933-34	November 13—December 8 ...	3	November 13—19 ...	77—85	57—65	81.3	62.4
			November 20—26 ...	83—87	63—67	84.9	64.7
			November 27—December 3 ...	81—85	51—64	82.3	57.6
			December 4—10 ...	80—83	53—58	81.3	54.6
			December 11—17 ...	79—84	52—65	80.7	57.3
			December 18—24 ...	79—84	59—64	81.1	61.6
			December 25—31 ...	79—83	51—56	81.0	53.7
			January 1—7	78—84	52—61	80.6	57.1

APPENDIX D—*contd.*

Year	Period of spore showers	Number of slides on which spore showers were detected	Period for which temperature data are given	Weekly range		Weekly average	
				Maximum	Minimum	Maximum	Minimum
			4. Dohad				
1933-34	November 22—January 24 ...	7	November 22—28 ...	87—91	60—67	89.4	62.4
			November 29—December 5 ...	85—90	51—65	87.7	55.0
			December 6—12 ...	84—87	48—55	86.0	51.0
			December 13—19 ...	79—85	47—54	81.3	49.1
			December 20—26 ...	74—84	53—64	80.6	55.6
			December 27—January 2 ...	83—87	49—52	85.0	50.7
			January 3—9	74—86	54—59	82.6	56.3
			January 10—16	64—85	36—55	76.7	45.9
			January 17—23	71—83	32—47	78.0	42.3
			January 24—30	73—91	42—60	84.0	51.3
			January 31—February 6 ...	69—88	39—52	80.0	45.7
			February 7—13 ...	91—96	52—60	92.4	55.0
			February 14—20 ...	94—98	56—60	95.9	57.9
			February 21—27 ...	88—97	58—65	92.7	61.6

APPENDIX—contd.

Year	Period of spore showers	Number of slides on which spore showers were detected	Period for which temperature data are given	Weekly range		Weekly average	
				Maximum	Minimum	Maximum	Minimum
			4. Dohad—*contd.*				
1935-36	December 11—15	1	December 11—17 ...	80—87	54—61	83.6	57.3
			December 18—24	82—87	46—57	84.7	49.4
			December 25—31	85—89	48—55	87.4	50.9
			January 1—7	74—88	43—58	81.1	51.0
			January 8—14	80—85	48—54	83.1	50.9
			5. Baroda				
1935-36	January 24—28	1	January 24—30	81—90	42—55	84.1	48.0
			January 31—February 6 ...	82—92	48—56	86.3	51.7
			February 7—13	83—95	47—59	87.9	53.4
			February 14—20	85—90	55—63	87.7	59.0
			February 21—27 ...	88—93	55—63	90.0	58.9
			6. Jagudan (Ahmedabad)				
1933-34	November 14—17 ...	1	November 14—20 ...	87—93	63—75	90.6	68.1
			November 21—27 ...	87—93	64—73	91.0	69.0
			November 28—December 4 ...	88—92	58—67	90.3	63.4
			December 5—11	85—90	59—64	88.0	61.3
			December 12—18	80—85	57—60	83.1	58.0

APPENDIX

Year	Period of spore showers	Number of slides on which spore showers were detected	Period for which temperature data are given	Weekly range		Weekly average	
				Maximum	Minimum	Maximum	Minimum
			HYDERABAD-DECCAN				
			7. Himayatsagar (Hyderabad)				
1933-34	September 21—January 1	4	September 21—27 ...	78—89	69—71	83.6	70.1
			September 28—October 4 ...	86—89	71—73	87.0	72.1
			October 5—11 ...	79—90	71—73	85.9	72.3
			October 12—18 ...	77—86	69—73	82.0	71.3
			October 19—25 ...	74—86	67—72	79.4	69.6
			October 26—November 1 ...	84—88	62—68	86.0	63.6
			November 2—8 ...	85—87	56—58	85.7	57.3
			November 9—15 ...	85—89	59—70	86.6	66.4
			November 16—22 ...	70—88	60—68	80.6	64.9
			November 23—29 ...	83—88	58—72	85.0	65.3
			November 30—December 6 ...	82—85	53—56	83.0	54.7
			December 7—13 ...	80—82	53—59	81.0	55.0
			December 14—20 ...	73—83	54—68	78.6	62.3
			December 21—27 ...	82—85	57—69	82.4	63.0
			December 28—January 3 ...	79—83	55—59	80.9	56.0
			January 4—10 ...	76—82	61—65	79.4	62.9
			January 11—17 ...	82—87	51—62	84.3	56.3
			January 18—24 ...	80—85	52—57	82.3	54.4
			January 25—31 ...	80—93	59—66	85.7	61.9

APPENDIX D *contd*

Year	Period of spore showers	Number of slides on which spore showers were detected	Period for which temperature data are given	Weekly range		Weekly average	
				Maximum	Minimum	Maximum	Minimum
			Himayatsagar—*contd.*				
1935-36	January 13—17	1	January 13—19	85—92	61—69	88.4	63.7
			January 20—26	82—92	62—67	88.1	63.6
			January 27—February 2 ...	84—93	64—68	89.7	66.3
			February 3—9	79—88	64—67	85.0	65.6
			February 10—16	83—90	58—66	85.9	63.6
			February 17—19 ...	88—91	62—67	89.7	63.7
			MADRAS				
			8. Bellary				
1933-34	October 20—30 ...	2	October 20—26	84—89	64—74	85.7	70.0
			October 27—November 2 ...	84—87	67—70	85.1	68.6
			November 3—9	86—87	63—68	86.4	64.7
			November 10—16 ...	86—90	65—72	87.7	69.0
			November 17—23 ...	75—90	63—71	83.6	67.6
			November 24—30 ...	85—88	61—68	86.3	66.0

APPENDIX D

Year	Period of spore showers	Number of slides on which spore showers were detected	Period for which temperature data are given	Weekly range		Weekly average	
				Maximum	Minimum	Maximum	Minimum
			8. Bellary—*contd.*				
1934-35	February 18—22 ...	1	February 18—24 ...	94—96	65—71	95.0	68.9
			February 25—March 3 ...	94—96	71—73	94.7	72.3
			March 4—10	92—94	69—72	93.1	70.4
			March 11—17	93—97	69—75	95.0	71.3
			March 18—24	98—102	68—78	100.4	73.7
1935-36	October 18—22 ...	1	October 18—24	81—88	70—73	84.7	71.6
			October 25—31	81—90	70—74	86.9	71.7
			November 1—7	87—89	63—71	88.3	67.3
			November 8—14	84—89	64—70	86.4	67.0
			November 15—21 ...	84—87	61—68	85.4	64.3
			9. Coimbatore				
1932-33	August 18—22	1	August 18—24	85—91	70—75	88.1	72.6
			August 25—31	85—90	71—74	87.1	72.9
			September 1—7	79—86	71—73	83.9	72.1
			September 8—14 ...	84—88	70—72	86.3	71.0
			September 15—21 ...	84—88	70—72	86.4	71.0

APPENDIX D—*contd.*

Year	Period of spore showers	Number of slides on which spore showers were detected	Period for which temperature data are given	Weekly range		Weekly average	
				Maximum	Minimum	Maximum	Minimum
			10. Hebbal (Bangalore)				
1933-34	November 7—December 28 ...	3	November 7—13 ...	78—83	61—66	80.9	64.3
			November 14—20 ...	79—84	58—64	82.1	62.3
			November 21—27 ...	82—87	61—65	84.3	62.9
			November 28—December 4 ...	80—83	56—63	81.6	57.9
			December 5—11 ...	80—82	56—58	81.0	56.4
			December 12—18 ...	67—81	56—64	76.6	60.3
			December 19—25 ...	78—82	61—65	80.0	63.1
			December 26—January 1 ...	77—80	53—61	78.6	57.7
			January 2—8	75—83	56—63	78.0	60.0
			January 9—15	75—85	58—65	81.1	61.4
			January 16—22	79—84	56—58	81.6	57.3
			January 23—29	72—84	58—64	78.6	61.3
1934-35	December 1—5 ...	1	December 1—7	74—80	57—63	76.9	59.9
			December 8—14	74—79	57—63	77.6	59.6
			December 15—21 ...	75—80	56—61	78.3	59.0
			December 22—28 ...	78—80	55—61	79.0	57.3
			December 29—January 4 ...	79—81	56—59	80.0	56.6

APPENDIX D—*contd.*

Year	Period of spore showers	Number of slides on which spore showers were detected	Period for which temperature data are given	Weekly range		Weekly average	
				Maximum	Minimum	Maximum	Minimum
			Hebbal—*contd.*				
1936-37	October 9—December 12	2	October 9—15	74—85	66—70	81.1	67.9
			October 16—22	82—85	63—68	83.0	66.7
			October 23—29	78—82	61—67	80.4	64.7
			October 30—November 5 ...	74—86	63—67	80.3	65.1
			November 6—12	68—81	63—67	77.6	65.7
			November 13—19 ...	79—81	64—68	80.3	65.7
			November 20—26 ...	76—83	62—66	78.7	64.0
			November 27—December 3 ...	77—80	55—63	78.9	58.0
			December 4—10	78—81	54—64	80.3	60.3
			December 11—17 ...	77—80	57—62	78.6	59.4
			December 18—24† ...	74—84	62—67	80.8	64.3
			December 25—31	79—83	56—63	82.3	59.7
			January 1—7	77—84	55—65	80.7	59.1
			January 8—14	76—82	53—64	79.3	58.0

† Data for December 19 were not available

Year	Period of spore showers	Number of slides on which spore showers were detected	Period for which temperature data are given	Weekly range		Weekly average	
				Maximum	Minimum	Maximum	Minimum
			11. Mandya (Mysore)				
1932-33	December 20—January 20 ...	7	December 20—26 ...	78—84	53—63	80.4	58.7
			December 27—January 2 ...	82—85	59—63	83.9	60.7
			January 3—9	77—83	56—62	81.0	59.1
			January 10—16	80 -86	57—61	83.3	59.0
			January 17—23	79—88	56—64	84.4	60.9
			January 24—30	84—88	62—67	86.4	64.0
			January 31—February 6 ...	85—90	62—66	87.6	64.1
			February 7—13	88—90	60—65	89.3	63.0
			February 14—20	90—92	60—68	90.9	65.3
1933-34	November 13—February 5 ...		November 13—19 ...	82—85	59—68	83.9	63.6
			November 20—26 ...	83—87	63—66	85.0	65.0
			November 27—December 13 ...	80—85	58—64	83.0	61.3
			December 4—10	81—83	57—60	81.6	58.4
			December 11—17 ...	68—83	59—64	79.3	61.4
			December 18—24	78—85	62—67	82.1	64.9

APPENDIX td.

Year	Period of spore showers	Number of slides on which spore showers were detected	Period for which temperature data are given	Weekly range		Weekly average	
				Maximum	Minimum	Maximum	Minimum
			Mandya—*Contd.*				
			December 25—31	79—82	55—66	80.0	60.4
			January 1—7	77—84	57—64	80.4	60.4
			January 8—14	79—85	59—68	82.1	64.0
			January 15—21	81—85	58—62	83.0	59.9
			January 22—28	77—86	59—67	83.1	64.7
			January 29—February 4 ...	85—89	60—69	86.4	64.0
			February 5—11	83—87	57—61	85.6	58.1
			February 12—18 ...	87—89	60—65	88.6	62.4
			February 19—25 ...	89—91	59—64	89.9	62.0
			February 26—March 4 ...	91—93	62—66	91.9	64.3
			12. Hiriyur (Chitaldroog)				
1932-33	January 10—14	1	January 10—16	79—85	57—62	82.7	59.7
			January 17—23*	83—89	57—64	85.5	60.8
			January 24—30	84—89	63—67	87.4	65.3
			January 31—February 6 ...	86—91	64—71	88.6	68.4
			February 7—13	90—92	65—69	91.1	67.4

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APPENDIX :

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of Yellow Rust during :

Serial number	Province and station	Year	Period for which temperature data are given	Weekly range		Weekly average	
				Maximum	Minimum	Maximum	Minimum
	PUNJAB						
1	**Lyallpur**	1933-34 ...	December 4—10	70—81	44—56	75.6	49.4
			December 11—17 ...	70—74	41—44	72.3	42.0
			December 18—24	70—73	37—46	71.3	40.9
			December 25—31	70—73	42—48	71.0	44.0
		1934-35 ...	February 7—13	64—73	44—51	69.6	48.6
			February 14—20	60—74	49—55	61.0	51.3
			February 21—27	66—75	45—52	72.0	48.7
			February 28—March 6 ...	70—81	45—51	75.0	48.9
		1935-36 ...	December 31—January 6 ...	63—71	38—52	66.7	42.9
			January 7—13	56—67	31—37	62.0	34.0
			January 14—20†	59—72	34—43	68.3	36.3
			January 21—27	69—72	34—40	70.1	35.9

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APPENDIX E d

Serial number	Province and station	Year	Period for which temperature data are given	Weekly range		Weekly average	
				Maximum	Minimum	Maximum	Minimum
	UNITED PROVINCES						
2	**Agra**	1933-34 ...	January 6—12	63—76	40—52	71.0	46.9
			January 13—19	60—68	31—38	65.0	35.6
			January 20—26	62—70	30—41	65.9	35.9
			January 27—February 2 ...	60—80	33—53	68.7	42.0
		1934-35 ...	January 28—February 3 ...	67—73	44—56	70.9	50.6
			February 4—10	59—78	43—51	73.3	47.6
			February 11—17	73—87	44—63	81.1	50.6
			February 18—24	75—83	49—51	80.0	50.0
	"	1935-36 ...	December 15—21 ...	69—72	38—48	70.4	41.4
			December 22—28 ...	75—78	39—44	76.6	42.0
			December 29—January 4 ...	72—77	36—43	74.0	40.1
			January 5—11 ...	65—75	36—49	69.6	42.6
			January 12—15 ...	67—72	37—40	69.2	37.8

APPE X E—*c*

Serial number	Province and station	Year	Period for which temperature data are given	Weekly range		Weekly average	
				Maximum	Minimum	Maximum	Minimum
3	**Benares**	1933-34 ...	January 15—21 ...	66—77	39—47	70.7	41.9
			January 22—28* ...	67—80	41—47	73.7	43.2
			January 29—February 4 ...	65—87	41—57	72.1	47.7
			February 5—11 ...	74—83	41—50	77.9	46.1
			February 12—18 ...	82—88	53—65	83.9	57.0
		1934-35 ...	January 21—27	71—82	37—56	76.7	45.9
			January 28—February 3 ...	73—85	49—61	77.0	56.1
			February 4—10	67—79	52—57	73.7	53.9
			February 11—17 ...	78—93	49—59	84.3	54.3
		1935-36 ...	December 23—29 ...	73—78	44—51	76.0	47.3
			December 30—January 5 ...	72—81	43—53	76.0	46.4
			January 6—12 ...	73—78	44—50	74.6	47.1
			January 13—19 ...	72—75	40—47	73.0	42.4

Data foı ıry 28 ıilable

APPENDIX E—*contd.*

Serial number	Province and station	Year	Period for which temperature data are giaen	Weekly range		Weekly averag.	
				Maximum	Minimum	Maximum	Minimum
	BIHAR						
4	**Pusa**	1933-34 ...	December 22—28	73.1—75.0	48.6—52.7	74.2	50.6
			December 29—January 4 ...	73.1—76.7	48.8—52.0	75.0	50.1
			January 5—11 ...	71.0—77.1	44.7—57.3	75.2	51.8
			January 12—18	64.4—75.2	41.5—56.6	69.6	7.1
	"	1934-35 ...	December 11—17	71.7—75.1	50.9—52.7	74.1	51.4
			December 18—24	73.2—75.6	47.6—55.2	74.5	52.3
			December 25—31 ...	70.2—74.8	46.7—55.5	73.4	51.2
			January 1—7	62.9—70.0‡	41.8—47.9	66.1‡	44.7
		1935-36 ...	December 24—30 ...	72.8—74.2	42.3—46.9	73.6	45.3
			December 31—January 6 ...	71.0—75.0	40.7—48.7	72.7	44.3
			January 7—13	71.5—75.0	41.0—46.0	73.4	43.6
			January 14—20	69.0—75.0	38.9—41.6	71.4	40.4

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APPENDIX

Serial number	Province and station	Year	Period for which temperature data are given	Weekly range Maximum	Weekly range Minimum	Weekly average Maximum	Weekly average Minimum
	CENTRAL PROVINCES						
5	**Jubbulpore**	1933-34 ...	February 4—10	75—83	36—43	78.9	38.9
			February 11—17	83—92	47—58	87.0	51.3
			February 18—24	86—93	50—55	89.6	52.9
			February 25—March 3 ...	87—95	52—60	91.4	55.1
		1934-35 ...	January 21—27	71—84	37—58	79.7	48.1
			January 28—February 3 ...	75—84	52—59	78.3	55.6
			February 4—10	75—84	51—56	80.0	53.1
			February 11—17	79—91	47—59	85.0	52.7
		1935-36)(...	January 4—10	75—83	42—51	77.7	47.9
			January 11—17	73—81	38—56	76.3	46.0
			January 18—24	73—88	37—60	76.9	48.4
			January 25—31	72—79	40—54	75.6	45.6
			February 1—7	76—85	43—60	79.1	50.6
			February 8—14	75—80	45—55	77.6	50.9
			February 15—21	81—86	43—59	83.6	53.0
			February 22—28	83—89	51—64	85.9	58.6
			February 29—March 6 ...	85—95	59—66	90.1	61.3
			March 7—13 ...	85—92	48—65	88.1	56.6

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APPENDIX F

Possibly relevant winds not followed by spore showers and data of rainfall, if any, soon after those winds

Year	Date of rust appearance	Height of wind-trajectory in feet above sea level	Date of wind-trajectory	Area wherefrom the wind was traceable	Dates of rainfall Amount within brackets
			brown rust		
			Lyallpur		
1937-38	April 1 ...	1640	March 15 ...	Siwalik range ...	March 15—16 (T)
	April 1 ...	3280	March 15 ...	Kashmir ...	March 18 (0.3)
			Delhi		
1937-38	February 15 ...	4920	January 28 ...	Kashmir	
	February 15 ...	6560	January 28 ...	Kashmir ...	January 31 (0.1)
	February 15 ...	6560	January 29 ...	Kashmir	
			Pusa		
1934-35	December 9 ...	1640	November 22 ...	Western Nepal ...	November 22 (T)
	December 9 ...	3280	November 22 ...	Central Nepal	
			yellow rust		
			Lyallpur		
1937-38	January 17 ...	1640	December 29 ...	Kashmir ...	December 30 (0.1)
			Pusa		
1932-33	February 3 ...	3280	January 17 ...	Siwalik range	
	February 3 ...	4920	January 17 ...	Central Nepal ...	January 20, 23 (T)
	February 3 ...	6560	January 18 ...	Central Nepal	
	February 3 ...	3280	January 19 ...	Central Nepal	

T indicates rainfall of 1 to 4 cents

APPE] X G

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Map number	Station	Year	Height of the wind in feet above sea level	Date of wind-trajectory	Date of rust appearance, as reported from the station. Incidence* within brackets	Dates of rainfall, if any; amount within brackets
2	**Lyallpur**	1932-33 ...	1,640	April 4† ...	April 20	No rain
		1932-33 ...	3,280	April 4† ...	April 20	No rain
		1932-33 ...	4,920	April 4† ...	April 20	No rain
6	**Sakrand**	1934-35 ...	3,280	February 11 ...	March 4 ... ... (March 7; 5-20 per cent)	Data not available
		1934-35 ...	4,920	February 11 ...	March 4 ... ... (March 7; 5-20 per cent)	Data not available
9	**Agra**	1937-38 ...	6,560	January 31 ...	February 19	No rain
10	**Gorakhpur**	1936-37 ...	1,640	December 14 ...	No information ... ... (January 5—6; traces)	No rain
32	**Parbhani**	1935-36 ...	3,280	January 6 ...	January 23	No rain
33	**Parbhani**	1935-36 ...	4,920	December 24 ...	January 23	No rain
38	**Coimbatore**	1933-34 ...	4,920	January 12 ...	February 3	No rain
40	**Mandya (Mysore)** ...	1937-38 ...	3,280	December 22 ...	January 21	No rain

Observations made by members (R(Staff Range iffere diff(varieties at that locality

Slides were not exposed after Ap

APPENDIX G—co

Map number	Station	Year	Height of the wind in feet above sea level	Date of wind-trajectory	Date of rust appearance, as reported from the station. Incidence within brackets	Dates of rainfall, if any ; amount within brackets
42	**Mandya (Mysore)** ...	1933-34 ...	6,560	November 18 ...	December 19 ... ... (December 19 ; 10 per cent)	No rain
44	**Chitaldroog**	1936-37 ...	3,280	November 10 ...	No information ... ... (January 2—3 ; 25-100 per cent)	November 12 and 13 (0.9)
45	**Chitaldroog**	1936-37 ...	4,920	November 13 ...	No information ... ... (January 2—3 ; 25-100 per cent)	November 13 (0.6)
46	**Chitaldroog**	1936-37 ...	6,560	November 9 ...	No information ... ... (January 2—3 ; 25-100 per cent)	November 10, 12 and 13 (2.5)

APPENDIX G—co

8, 9, 60, 62, 64, 70, 71
n soon after those win

Map number	Station	Year	Height of the wind in feet above sea level	Date of wind-trajectory	Date of rust appearance, as reported from the station.	Dates of rainfall, if any; amount within brackets
57	**Hoshiarpur**	1936-37 ...	1,640	December 22 ...	January 15	December 25—27 (0.34)
		1936-37 ...	3,280	December 22 ...	January 15	December 25—27 (0.34)
		1936-37 ...	4,920	December 22 ...	January 15	December 25—27 (0.34)
		1936-37 ...	6,560	December 22 ...	January 15	December 25—27 ; (0.34)
58	**Karnal**	1934-35 ...	1,640	February 4 ...	February 26	February 4 (0.05)
59	**Sakrand**	1936-37	1,640	February 23 ...	March 20	February 25 (0.22)
60	**Delhi**	1937-38 ...	1,640	January 25 ...	February 15	January 25—26 (1.7)
62	**Agra**	1936-37 ...	1,640	January 25	February 15	No rain
64	**Agra**	1936-37 ...	6,560	January 27 ...	February 15	No rain
70	**Sabour**	1936-37 ...	1,640	December 10 ...	January Early	No rain
		1936-37 ...	3,280	December 10 ...	January Early	No rain
		1936-37 ...	4,920	December 10 ...	January Early	No rain
71	**Sabour**	1936-37 ...	6,560	December 11 ...	January Early	No rain
80	**Jubbulpore**	1934-35 ...	3,280	January 27 ...	February 17	January 29 (T)

T rep of rainf

APPENDIX G—*contd.*

Relevant winds for Yellow Rust, ·eproduced in Map Nun 95 to 104, 10· 111, 115 an which were not followed by spor· wers and data of rainfal any, soon aft· ·ose winds

Map number	Station	Year	Height of the wind in feet above sea level	Date of wind-trajectory	Date of rust appearance, as reported from the station	Dates of rainfall, if any ; amount within brackets
95	**Lyallpur**	1933-34 ...	3,280	December 5 ...	December 31	December 5 (T)
96	**Hoshiarpur**	1937-38 ...	1,640	February 4 ...	February 22	February 4, 6 and 7 (0.95)
	Hoshiarpur	1937-38 ...	3,280	February 4 ...	February 22	February 4, 6 and 7 (0.95)
	Hoshiarpur	1937-38 ...	4,920	February 4 ...	February 22	February 4, 6 and 7 (0.95)
97	**Hoshiarpur**	1936-37 ...	6,560	December 10 ...	January 5	No rain
98	**Rawalpindi**	1933-34 ...	3,280	February 15 ...	March 1	
99	**Karnal**	1936-37 ...	1,640	January 6 ...	January 22	No rain
100	**Karnal**	1936-37 ...	3,280	December 23 ...	January 22	No rain
101	**Karnal**	1936-37 ...	4,920	January 5 ...	January 22	No rain
	Karnal	1936-37 ...	6,560	January 5 ...	January 22	No rain
102	**Sakrand**	1935-36 ...	1,640	February 9 ...	February 28	No rain
103	**Delhi**	1937-38 ...	1,640	January 15 ...	February 2	No rain
104	**Agra**	1934-35 ...	1,640	January 30 ...	February 24	No rain
106	**Agra**	1936-37 ...	3,280	January 30 ...	February 15	No rain
107	**Agra**	1937-38 ...	4,920	February 2 ...	February 19	No rain

Map number	Station	Year	Height of the wind in feet above sea level	Date of wind-trajectory	Date of rust appearance, as reported from the station	Dates of rainfall, if any ; amount within brackets
108	**Agra**	1932-33 ...	6,560	January 16 ...	February 15	No rain
109	**Gorakhpur**	1934-35 ...	1,640	January 4 ...	January 28	No rain
	Gorakhpur	1934-35 ...	3,280	January 4 ...	January 28	No rain
	Gorakhpur	1934-35 ...	4,920	January 4 ...	January 28	No rain
	Gorakhpur	1934-35 ...	6,560	January 4 ...	January 28	No rain
110	**Pusa**	1934-35 ...	1,640	December 21 ...	January 7	December 22 (few drops)
111	**Pusa**	1934-35 ...	3,280	December 19 ...	January 7	December 22 (few drops)
		1934-35 ...	4,920	December 19 ...	January 7	December 22 (few drops)
		1934-35 ...	6,560	December 19 ...	January 7	December 22 (few drops)
115	**Sabour**	1934-35	1,640	February 9 ...	March 4	No rain
116	**Sabour**	1934-35 ...	3,280	February 14 ...	March 4	February 18 (0.6)

APPENDIX H

Son case. of delay appı 'ance of Black Rust following the firs. spore shower

Year	Dates of first spore shower. Subsequent showers within brackets	Date of rust appearance	Period intervening between the last day of first spore shower and the date of rust appearance	Period for which humidity and rainfall data are given	Weekly range of humidity; average within brackets	Number of days of rainfall; amount and date within brack ts
				Hebbal near Bangalore		
1937-38	December 27—31 (January 3—7) ...	January 22 ...	3 weeks ...	December 27—January 2	76—94 per cent (86.1 per cent)	4 (F)
				January 3—9 ...	77—96 per cent (85.7 per cent)	1 (F)
				January 10—16 ...	79—90 per cent (84.3 per cent)	3 (F)
				January 17—22 ...	53—95 per cent (79.0 per cent)	No rain.
				Agra		
1930-31	January 21—24 (January 24—31) ...	February 22 ...	4 weeks ...	January 21—27 ...	49—75 per cent (66.6 per cent)	No rain
				January 28—February 3 ...	38—79 per cent (57.4 per cent)	1 (.1 ; February 1)
				February 4—10 ...	30—98 per cent (60.6 per cent)	1 (T ; 8)
				February 11—17 ...	53—91 per cent (79.4 per cent)	No rain
				February 18—22 ...	49—95 per cent (80.8 per cent)	1 (.1 ; 21)

APPENDIX H—*contd.*

Year	Dates of first spore shower. Subsequent showers within brackets	Date of rust appearance	Period intervening between the last day of first spore shower and the date of rust appearance	Period for which humidity and rainfall data ara given	Weekly range of humidity; average within brackets	Number of days of rainfall; amount and date within brackets
				Dehradun		
1937-38	February 22—25 ...	March 31 ...	5 weeks ...	February 22—28 ...	69—91 per cent (77.6 per cent)	No rain
	(March 1—4) ...			March 1—7	54—76 per cent (62.0 per cent)	No rain
	(March 4—8) ...			March 8—14 ...	38—83 per cent (58.3 per cent)	1 (T; 11)
	(March 8—12) ...			March 15—21 ...	33—70 per cent (49.7 per cent)	1 (T; 17)
	(March 12—15) ...			March 22—28 ...	40—52 per cent (46.7 per cent)	No rain
				March 29—31 ...	30—42 per cent (34.6 per cent)	No rain
				Jubbulpore		
1936-37	December 9—12 ...	End of January	7 weeks ...	December 9—15 ...	76—87 per cent (81.9 per cent)	1 (T; 10)
	(December 23—26) ...			December 16—22* ...	79—99 per cent (88.5 per cent)	1 (1.1; 20), 2 (F)
	(December 26—30) ...			December 23—29 ...	58—96 per cent (78.0 per cent)	No rain
	(December 30—January 2)			December 30—January 5	77—88 per cent (81.4 per cent)	No rain
	(January 6—9) ...			January 6—12 ...	46—73 per cent (67.0 per cent)	No rain
	(January 9—13) ...			January 13—19 ...	56—80 per cent (68.7 per cent)	No rain
				January 20—26 ...	50—84 per cent (71.1 per cent)	No rain
				January 27—31 ...	57—74 per cent (66.6 per cent)	No rain

* Data for December 19, were not available

APPENDIX H

Year	Dates of first spore shower. Subsequent showers within brackets	Date of rust appearance	Period intervening between the last day of first spore shower and the date of rust appearance	Period for which humidity and rainfall data are given	Weekly range of humidity ; average within brackets	Number of days of rainfall ; amount and date within brackets
				Agra		
1932-33	December 31—January 3 ...	March 5 ...	9 weeks ...	December 31—January 6	59—93 per cent (73.0 per cent)	No rain
	(January 21—24) ...			January 7—13 ...	36—55 per cent (48.1 per cent)	No rain
	(February 14—18) ...			January 14—20 ...	30—73 per cent (52.9 per cent)	No rain
				January 21—27 ...	50—100 per cent (73.0 per cent)	No rain , 1 (F)
				January 28—February 3 ...	37—64 per cent (47.7 per cent)	No rain
				February 4—10 ...	41—74 per cent (59.6 per cent)	No rain
				February 11—17 ...	51—94 per cent (72.6 per cent)	No rain
				February 18—24 ...	34—92 per cent (67.6 per cent)	2 (T ; 21, 24)
				February 25—March 3 ...	53—97 per cent (71.9 per cent)	2 (T; 1 ; 26, 27)
				March 4—5 ...	44—54 per cent (49.0 per cent)	No rain

T represents 1—4 cents of rainfall
F representsfog

Year	Dates of first spore shower. Subsequent if any showers brackets	Date of rust appearance	Period intervening between the last day of first spore shower and the date of rust appearance	Period for which humidity and rainfall data are given	Weekly range of humidity ; average within brackets	Number of days of rainfall ; amount and date within brackets
				Lyallpur		
1934-35	February 18—21 ...	March 15 ...	3 weeks ...	February 18—24 ...	83–93 per cent (87.0 per cent)	No rain
				February 25—March 3 ...	46–87 per cent (71.1 per cent)	1 (T ; 2)
				March 4—10 ...	45—58 per cent (51.7 per cent)	No rain
				March 11–15 ...	51–69 per cent (61.0 per cent)	No rain
				Agra		
1935-36	January 4–6 ...	February 5 ...	4 weeks ...	January 4–10 ...	53–73 per cent (62.7 per cent)	No rain
	(January 6–8) ...			January 11–17 ...	42–63 per cent (51.3 per cent)	No rain
	(January 8—10) ...			January 18–24 ...	48–81 per cent (63.1 per cent)	No rain
				January 25–31 ...	42–86 per cent (58.6 per cent)	1 (T ; 30)
				February 1–5 ...	38–53 per cent (44.2 per cent)	No rain

Year	Dates of first spore shower. Subsequent if any, showers within brackets	Date of rust appearance	Period intervening between the last day of first spore shower and the date of rust appearance	Period for which humidity and rainfall data are given	Weekly range of humidity ; average within brackets	Number of days of rainfall ; amount and date within brackets
				Lyallpur		
1935-36	February 15—18 ...	March 27 ...	6 weeks ...	February 15—21 ...	46—71 per cent (61.4 per cent)	No rain
	(February 18—21) ...			February 22—28 ...	58—100 per cent (85.0 per cent)	2 (.4 ; 23, 27), 2 (F)
	(February 25—29) ...			February 29—March 6 ...	71—93 per cent (80.3 per cent)	2 (1.4 ; 1, 2)
	(February 29—March 3)			March 7—13 ...	44—85 per cent (68.9 per cent)	No rain
	(March 3—6) ...			March 14—20 ...	37—67 per cent (46.3 per cent)	No rain
	(March 16—10) ...			March 20—27 ...	42—60 per cent (48.3 per cent)	No rain
	(March 10—14) ...					
				Dehradun		
1937-38	February 8—11 ...	March 31	7 weeks ...	February 8—14 ...	65—90 per cent (78.4 per cent)	1 (.6 ; 8)
	(February 11—15) ...			February 14—21 ...	65—91 per cent (77.3 per cent)	2 (.4 ; 15, 16)
	(February 15—18) ...			February 22—28 ...	69—91 per cent (77.6 per cent)	No rain
	(February 18—22) ...			March 1—7 ...	54—76 per cent (62.0 per cent)	No rain
	(March 1—4) ...			March 8—14	38—83 per cent (58.3 per cent)	1 (T ; 11)
	March 12—15) ...			March 15—21 ...	33—70 per cent (49.7 per cent)	1 (T ; 17)
				March 22—28 ...	42—50 per cent (46.7 per cent)	No rain
				March 29—31 ...	30—42 per cent (34.6 per cent)	No rain

F represents fog
T represents 1—4 cents of rainfall

APPENDIX H—*contd.*

Some cas of dela the appearance of Yellow Rust following the 'r. spore showers

Year	Dates of first spore shower. Subsequent showers within brackets	Date of rust appearance	Period intervening between the last day of first spore shower and the date of rust appearance	Period for which humidity and rainfall data are given	Weekly range of humidity ; average within brackets	Number of days of rainfall ; amount and date within brackets
				Jubbulpore		
1934-35	January 21—24 ...	February 17 ...	4 weeks ...	January 21—27 ...	68—82 per cent (74.4 per cent)	No rain
	(January 31—February 3)			January 28—February 3 ...	70—97 per cent (87.4 per cent)	2 (T, .1, 30, 31)
	(February 3—7) ...			February 4—10 ...	76—97 per cent (83.3 per cent)	1 (.3 ; 4)
				February 11—17 ...	44—76 per cent (62.0 per cent)	No rain
				Lyallpur		
1934-35	January 31—February 4 ...	March 7 ...	5 weeks ...	January 31—February 6 ...	89—96 per cent (92.0 per cent)	3 (T, .5 ; 3-5), 2 (F)
	(February 11—14) ...			February 7—13 ...	59—90 per cent (79.4 per cent)	1 (T ; 12)
				February 14—20 ...	75—93 per cent (87.1 per cent)	2 (1.4 ; 15, 16)
				February 21—27 ...	65—87 per cent (81.9 per cent)	No rain
				February 28—March 7 ...	45—87 per cent (51.0 per cent)	1 (T ; 2)

T represents 1—4 cents of rainfall
F represents fog

APPENDIX H

Year	Dates of first spore shower. Subsequent showers within brackets	Date of rust appearance	Period intervening between the last day of first spore shower and the date of rust appearance	Period for which humidity and rainfall data are given	Weekly range of humidity; average within brackets	Number of days of rainfall; amount and date within brackets
				Dehradun		
1937-38	January 21—25 ...	March 5 ...	6 weeks ...	January 21—27 ...	67—92 per cent (83.1 per cent)	2 (.7 ; 25, 26)
	(January 25—28) ...			January 28—February 3 ...	79—95 per cent (89.1 per cent	5 (T, 2.0 ; 30, 31, 1, 2, 3)
	(February 15—18) ...			February 4—10 ...	73—95 per cent (84.9 per cent)	3 (T, .8 ; 6-8)
	(February 18—22) ...			February 11—17 ...	65—91 per cent (77.4 per cent)	2 (.4 ; 15, 16)
				February 18—24 ...	65—91 per cent (76.4 per cent)	No rain
				February 25—March 3 ...	56—81 per cent (66.3 per cent)	No rain
				March 4—5	54—67 per cent (60.5 per cent)	No rain
				Gorakhpur		
1932-33	November 14—19 ...	January 10 ...	8 weeks ...	November 14—20 ...	71—97 per cent (87.1 per cent)	No rain
	(November 19—22) ...			November 21—27 ...	75—94 per cent (85.6 per cent)	No rain
	(November 22—25) ...			November 28—December 4	76—94 per cent (85.0 per cent)	No rain
	(November 25—30) ...			December 5—11 ...	69—94 per cent (86.9 per cent)	No rain
	(November 30—December 3)			December 12—18 ...	74—93 per cent (88.1 per cent)	No rain
	(December 3—6) ...			December 19—25 ...	80—97 per cent (92.0 per cent)	1 (.6 ; 25)
	(December 6—12) ...			December 26—January 1	72—93 per cent (81.4 per cent)	1 (.1 ; 30)
				January 2—8 ...	63—92 per cent (76.3 per cent)	No rain
				January 9—10 ...	77—78 per cent (77.5 per cent)	No rain

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SECTION V—CONTROL OF EPIDEMICS BY DIRECT MEANS

CONTENTS

1. INTRODUCTION

In some of the earlier contributions [Mehta, 1931, 1933, 1939] the writer observed that all the three rusts of wheat are propagated by uredospores from season to season in the hills of India. The rôle of *Berberis* and *Thalictrum*, alternate hosts of black rust of cereals and the brown rust of wheat respectively, in the yearly origin of those rusts has also been fully discussed in the previous monograph [Mehta, 1940] and the writer feels convinced that unlike most of the European countries, Canada and U.S.A. the eradication of barberries would be thoroughly inadvisable for the control of black rust in India. The same applies to the control of brown rust by the destruction of *Thalictrum*. Both the alternate hosts grow abundantly in the hills and even after their destruction, at a cost of millions of rupees, epidemics of black and brown rusts should still recur unabated because of their oversummering on self-sown plants and ratoon tillers from harvested plants at various altitudes in the hills.

This section deals with the subject matter of a popular note, on certain methods of rust control, which the writer wrote at the instance of the Imperial (now Indian) Council of Agricultural Research, India in January 1937. The note was originally submitted for purposes of publicity and detailed discussion on the practicability of the writer's proposals regarding the control of rust epidemics of wheat and barley‡ in different parts of India as well as Nepal.

Since then the proposals have been examined and discussed by various learned bodies of the Imperial (now Indian) Council of Agricultural Research as well as by the Government of Nepal, and the writer hopes that in course of time steps will be taken by the Governments concerned to enforce them. Slight modifications have been made in the original proposals, following the discussions referred to above. It might be mentioned that wheat and barley are usually sown in separate terraces in the hills and the individual holdings are rather small. Out of the total acreage of nearly 35 and 8 millions, respectively under wheat and barley, hardly 5 per cent area lies in the hills and hilly tracts.

2. MEASURES OF CONTROL

(*i*) The writer [Mehta, 1929] suggested that in order to eradicate rusts at the source, it would be necessary to destroy rigorously all self-sown plants and ratoon tillers from harvested plants of wheat and barley and suspend the cultivation of these crops for 2-3 years in the hills. This method would be impracticable without the co-operation of neighbouring States which extend over a considerable part of the hilly area.

(*ii*) Dusting the wheat crop with sulphur, which has been attempted on a small scale in some parts of North America, would be impracticable in this country because nearly 80 per cent of the area under the wheat crop is covered by the highly susceptible, indigenous (*dési*) varieties. This method would

‡ The results outlined in this section and the methods of control suggested are also applicable to the barley crop, which suffers from two out of the three rusts found on wheat.

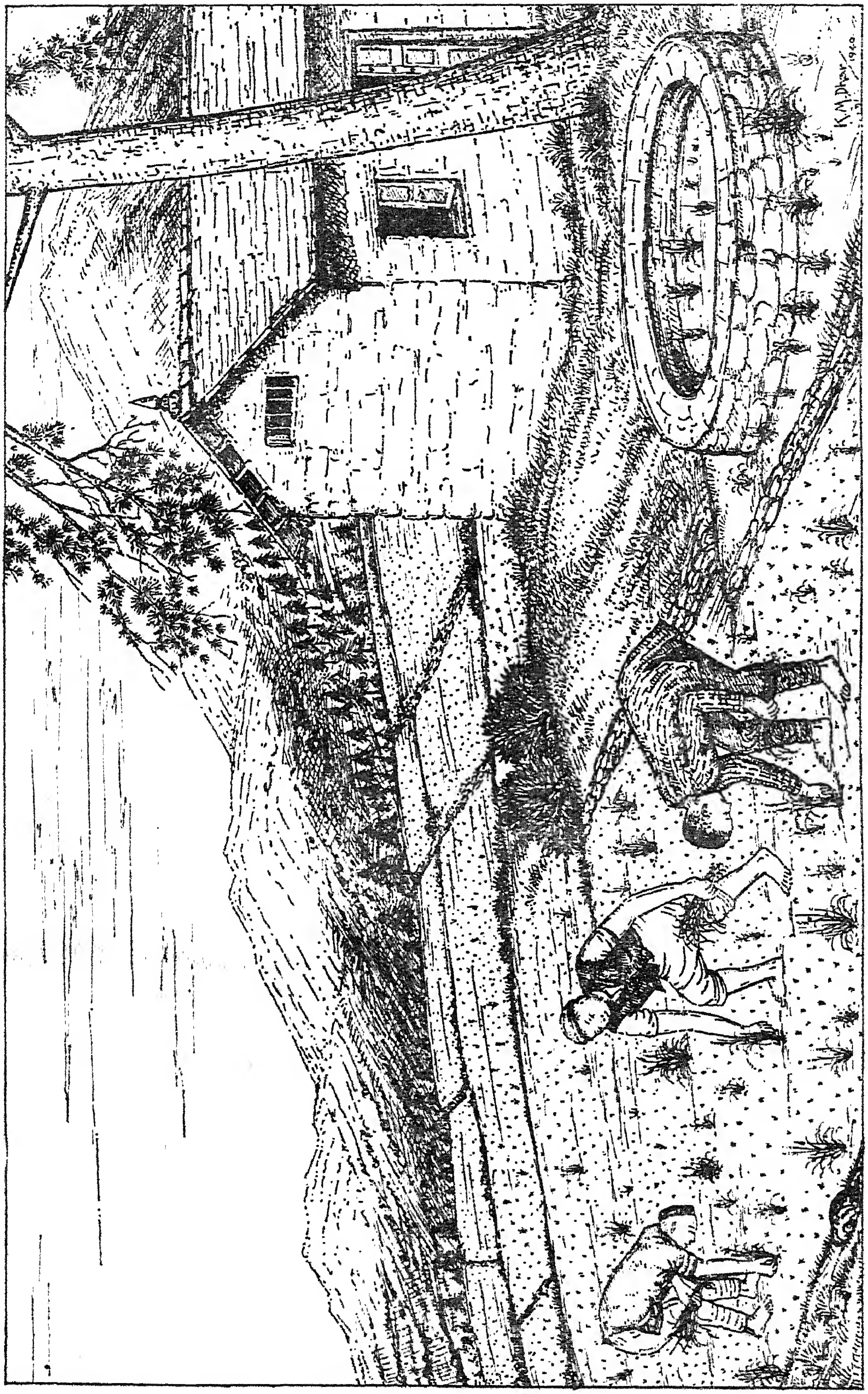

Diagram showing 'out of season' wheat and barley growing in terraces in the hills as well as the threshing floor. The method of 'clean-up' is also illustrated.

involve huge expense for weekly applications of sulphur and price of machines, aeroplanes, etc. Besides, on account of prevailing dry weather in the plains most of the powder is likely to be blown off the surface of plants by wind.

(*iii*) The other method of control which is universally recognized is to cultivate resistant varieties. For the reasons given previously in this monograph, in this country it would suffice to grow resistant varieties *only* in the hills wherefrom rusts are re-introduced every year into the plains.

(*iv*) 'Clean-up', i.e., rigorous destruction of 'out of season' wheat and barley, 1-2 months before normal sowings in all the hills and hilly tracts should be an effective method of control.

(*v*) In view of the small acreage under the early crops in the Nilgiris, Palnis and Nepal, suspension of the first crop sown during April to August in the first two areas and postponement of early sowings in central Nepal to the normal period, *i.e.*, October, would be the most promising methods of direct control of rusts in Peninsular India and the Indo-Gangetic plain respectively.

With regard to No. (*iii*), it may be mentioned that the task of breeding a wheat or wheats, which would resist all the physiologic races of the three rusts, and of providing enough seed for over 1,500,000 acres, the area under wheat in the hills, will take several years. Besides, it may be necessary to pass legislation enforcing the cultivation of only resistant varieties, when available, in the hills. Taking the long view and considering the international importance of the crop work on the breeding of resistant varieties which was started by the Imperial* Economic Botanist in 1935 in collaboration with the writer should continue at all costs. Breeding of rust resistant varieties of barley for cultivation in the hills should also be taken in hand as soon as possible.

In this connection, reference may be made to some important observations of Stakman [1935] who states that 'rust resistance' is a variable character, like any other plant character. On the basis of recent investigations, this author has pointed out that even so resistant a variety as Hope may rust quite normally when the light intensity is reduced and that under cloudy conditions when there is considerable moisture it may be heavily rusted if large numbers of spores are present in the air. Further, the fact that varieties like Hope and Ceres, having so-called 'mature resistance' which tends to protect them against all parasitic strains, rust heavily under certain conditions indicates clearly that the perfectly resistant wheat has not yet been developed.

Weather conditions such as those described by Stakman are of frequent occurrence in the hills of India and Nepal, and in the light of his observations it seems that the 'clean-up' method would have to be enforced in those places even when resistant varieties are available, in order to reduce the inoculum growing on self-sown plants and ratoon tillers from harvested plants.

For the reasons given above and notwithstanding the difficulties of supervision in hilly areas and a certain amount of expense to the Provincial Governments and States for such arrangements, the writer is convinced that methods (*iv*) and (*v*) should be effective in mitigating considerably the huge loss of Rs. 60,000,000 or so caused by rusts from year to year. Detailed proposals for British India, States and Nepal are given in sub-heads 3 and 4 below.

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3. PROPOSALS FOR BRITISH INDIA AND THE STATES*

(*a*) *For all the hilly tracts and hills up to altitudes of 5,000 feet and from 5,000 to 9,000 feet or so above sea level*

(*i*) The present practice of sowing wheat and barley before October at some of the lower altitudes should be discontinued because such sowings give a good start to rusts and are, therefore, a source of danger to the normal crop sown in October-November in the hills as well as in the plains. At altitudes of 5,000 to 9,000 feet wheat and barley may be sown about the middle of October. At such places it would perhaps be better to grow only early varieties or European spring wheats so that the harvest may be over before the monsoon breaks.

(*ii*) Land lying fallow and required for wheat should be prepared 1-2 months before sowing and all self-sown plants of wheat and barley, their stubble and ratoon tillers from harvested plants, although looking healthy, should be up-rooted and destroyed.

(*iii*) Self-sown plants, ratoon tillers from harvested plants and stubble along the hedges, in the drains, at the threshing floor, on the way to and near the residential quarters, godowns, etc., should also be up-rooted and destroyed.

(*iv*) In short, every cultivator should develop an instinct to destroy 'out of season' wheat and barley plants whenever and wherever found before sowing and after the harvest.

In view of the fact that in the hills and hilly tracts there are only small holdings, the writer sees no reason why the cultivator, his wife, and children, who can all distinguish wheat and barley in the vegetative stage, should not be able to remove and destroy these plants without the help of additional labour. Once they are convinced by experience that stray plants are injurious to the crop, no further persuasion would be necessary for this method of control, which would be effective and inexpensive.

(*b*) *For hills above altitudes of 9,000 feet or so*

There is a very small area under wheat at such altitudes, sown usually in April-May. Cultivation should be so controlled that wheat and barley are harvested by the end of August, and all self-sown plants and ratoon tillers destroyed immediately after the harvest. A diseased crop standing at such altitudes until October-November would be a source of infection to the normal crop sown at about that time at lower altitudes and in the plains.

As far as possible, wheat and barley should not be sown after the end of April at such altitudes. In the event of a serious difficulty regarding the time of harvesting, it would perhaps be best to cultivate only early varieties or Europea spring wheats.

(*c*) *Special measures for the Nilgiris, Palni hills and the Devikulum area of Travancore*

At higher altitudes (6,000-7,000 feet bove sea level) in these hills there are two crops of wheat and barley each year. The first is sown during April to June and the second in September to November. Wheat is also sown on a

* A brief account of these measures was given by the writer while opening a discussion on the Dissemination of Cereal Rusts in India before the Botany Section of the 25th Indian Science Congress (Jubilee Session) 1938. *Proc. 25th Indian Sc. Cong.* 1938 **4**, 137 (1939)

small scale during June to August in these areas. The total area under the first crop in these parts is only 3,500 acres or so.

(*i*) In view of what has been said above, it is necessary that the harvesting of the first crop be over by the end of August and for that reason no sowings should be made after April. The second crop should not be sown before October. If, however, it is not possible to re-adjust the periods of sowing and harvesting, as suggested above, the first crop should be entirely suspended for 2-3 years and some other cereal grown instead.

(*ii*) If it is decided to suspend the first crop, the second may be grown more extensively than at present.

(*iii*) All self-sown plants and ratoon tillers of wheat and barley should be removed soon after each harvest and before the sowings.

The presence of a rusted wheat crop, first or second, in the Nilgiris, the Palni hills and the Devikulum area from October onwards, is a source of danger to the normal crop (sown during October-November) in the hilly tracts as well as in the plains of Madras, Hyderabad-Deccan, Mysore and parts of the Bombay Presidency. In fact, the most serious focus in Peninsular India lies in the Nilgiris where two crops are sown over a larger area than in the Palnis.

(*d*) *Measures for the districts of Bellary, Chitaldroog (Mysore State) and any others where wheat or barley is sown during July to September, whether regularly or occasionally*

An early crop whenever and wherever sown acts as a focus of infection to the normal crop sown during October-November. No early sowings should therefore be allowed.

4. PROPOSALS FOR NEPAL

A very considerable amount of inoculum is blown down from the Nepal territory to British India as a result of which rusts break out in the eastern districts of the United Provinces rather early in the season (December-January).

The writer is convinced that such outbreaks are due to the presence of an early and well-advanced infection of the August-September crop in central Nepal (4,000-5,000 feet) as has been observed during the last three years. The following measures should considerably control early outbreaks of rusts in central Nepal as well as their dissemination to British India :

(*i*) The practice of showing wheat or barley anywhere before October should be discontinued at once.

5. A SHORT-TERM PLAN FOR THE CONTROL OF WHEAT RUSTS IN INDIA

This note has been written after full consideration of the urgent need of a short-term project in accordance with the recent 'Food Grain' policy of the Government of India and without prejudice to the continuance of work already in progress, in collaboration with the writer, for the breeding of rust resistant varieties or any other long-term investigations that may be under contemplation by the Central or Provincial Governments. The need for such a plan became imminent in view of the very serious rust epidemic of 1947 in Peninsular India as well as in the central parts of the country.

I. For Control in Peninsular India.

(*i*) Prohibition of cultivation of wheat and barley, by *strict* legislation, for a period of five years in the Nilgiris, Palni hills and Devikulum taluk of Travancore State.

Until the year 1943 the total acreage under the *Kharif* and *rabi* crops (taken together) in the above-mentioned areas was nearly 2,000. In place of both these crops Rye (*Secale cereale*) may be grown and in view of large-scale cultivation of Ergot on this cereal, in the Nilgiris under the guidance of Government Mycologist, Madras no compensation to cultivators should be necessary as they would get a far greater price for Ergot than they ever obtained from wheat or barley.

If, however, arrangements for the cultivation of Ergot in the whole of the area, at present under wheat and barley, present some serious difficulties or the weather conditions during either of the crop seasons are unfavourable for the growth of Ergot then Rye may be sown for purposes of food. If that too seems impracticable owing to unfavourable weather some other crop may be raised and a *fair* amount of compensation paid to the cultivators keeping in view the present day price of wheat.

Cultivation of wheat and barley may be resumed as soon as rust-resistant varieties, specially suitable for these areas, are available.

(*ii*) Prohibition of sowings of wheat and barley, by *strict* legislation, for a period of five years during *summer* (April to September) *all over* the plains, hilly tracts and hills in the Mysore State, Bombay Province, Deccan States, the Dangs snd Jeypore Agency Tract (Orissa). Sowings may be permitted from September 15 *only* at such places where local conditions of weather do not permit further delay.

II. For Control in other parts of the Dominion of India and States.

(*i*) Prohibition, by *strict* legislation, for five years of sowings of wheat and barley during summer, even in small patches, in the hills; there is no summer crop anywhere in the plains.

(*ii*) In the hills and hilly tracts wheat and barley crops should gradually be replaced by improved varieties of Oats, fit for human consumption, and Rye.

Oats are not effected by *any* of the wheat rusts and Rye is only weakly susceptible to black rust but the Government Mycologist, Madras has found some of the varieties grown in the Nilgiris to be highly resistant under natural conditions.

Rye is extensively cultivated in Europe for mixture with wheat flour and oats are also a favourable article of food both in Europe and America. Seed of the latter will have to be imported and increased here for distribution to cultivators in the hills and the quantity of Rye available in the country at present would be insufficient; more will have to be imported.

It should not be difficult to replace the whole of the acreage under wheat and barley in the hills (less than 5 per cent of the total area under these crops in the country as a whole) by Oats and Rye within 3 to 5 years.

The writer has little doubt that by adopting the above-mentioned measures the most obvious and serious foci of rust dissemination to the plains will be eliminated and that should lead to a very considerable mitigation of loss caused by the rusts under reference. Should any part of the country still suffer from a serious rust outbreak location of the source of infection would be very much easier than at present and necessary steps can be taken to deal immediately with the situation.

In order to obtain full co-operation of cultivators in the hills it would be necessary to supply them wheat, for purposes of food, in exchange for oats or rye.

It is important to note that the total yield of Food Grains, including oats and rye would be *considerably* greater than at present because (*i*) oats, proposed to be grown in the hills in place of wheat and barley, are not affected by wheat rusts and resistant varieties of rye are also available and (*ii*) the damage caused by rust to wheat and barley at present in the hills year after year will be largely mitigated if not completely stopped. Once the foci in the hills, where rusts oversummer on 'out of season' wheat and barley, are put out of action a very effective control should not be difficult to achieve during the short-term plan outlined above. The writer is convinced that a considerable amount of mitigation of loss should be achieved even during the first year of the adoption of measures outlined under I, (*i*) and (*ii*).

(*ii*) All self-sown plants of wheat and barley and their ratoon tillers should be removed and destroyed one month after the harvest and repeatedly during the two months before sowing.

(*iii*) If there is any area where two crops are raised in the year, the first should be harvested by the end of August or suspended and the second either suspended or not sown till October.

(*iv*) At altitudes of 9,000 feet or above wheat and barley should not be sown after April and should be harvested by the end of August at the latest.

Proposals for any special areas in Nepal can be made only after an intensive survey of rusts in that territory. So far, observations have been made only occasionally and in restricted areas.

While dealing with the control of brown rust of wheat by Regulation recently Chester [1946] has expressed complete agreement with the writer's proposals included in the previous monograph recommending suspension of the summer sown crop in the Nilgiris and Palni hills and postponement of sowings in central Nepal to October-November. These proposals apply equally to the other two rusts of wheat.

6. CONCLUSION

From the nature of the proposals relating to 'Clean-up' it is clear that anything like a complete eradication of rusts is not expected to result therefrom. At the same time, there seems to be no reason why a considerable amount of the inoculum should not be killed by the destruction of self-sown plants and ratoon tillers on which the rusts oversummer. The measure is simple and inexpensive and its success depends on how rigorously it is carried out.

Perhaps the best procedure would be to publish the instructions in the vernacular of each of the areas concerned and distribute leaflets to zemindars as well as the cultivators. Details of propaganda may be left to the respective

departments of Agriculture in the Provinces and the States. If necessary, these measures might be enforced by legislation.

In the earlier stages of the 'Clean-up' campaign rusts are likely to appear here and there at the usual time but the writer feels convinced that after rigorous enforcement, under adequate supervision, of the instructions given above rusts should not break out *early enough* to cause serious epidemics over large tracts in the plains of this country as at present.

Further, the adoption of special measures recommended for the Nilgiris, Palni hills and Devikulum area of Travancore should considerably cut down the total lass due to rusts in Peninsular India.

With the co-operation of the governments of Nepal and of the Hill States in the north, it should be possible to save large sums of money within a few years. By a steady diminution of the inoculum from the hills and hilly tracts the loss may be reduced to a negligible figure in course of time.

7. ACKNOWLEDGMENTS

The writer wishes to express his warmest thanks to the Governments of Nepal and the Dangs for permission to his assistants to study the incidence of rusts in their respective areas as well as for other facilities. Thanks of the writer are also due to the Directors of Agriculture in the various Provinces and States for the facilities provided in connection with these studies. The writer also wishes to record his warm appreciation of the assistance rendered by some members of the rust research staff in this work.

8. SUMMARY

This section deals with the subject matter of a popular note on the control of epidemics of wheat rusts in India by direct means.

As stated by the writer in a recent publication, eradication of barberries for the control of black rust would be inadvisable in India and the same applies to the control of brown rust by the destruction of *Thalictrum*. Even after the destruction of these alternate hosts, at a cost of millions of rupees, epidemics of black and brown rusts would still recur unabated because of their propagation like that of yellow rust by uredospores in the hills.

Specific proposals for control of rusts by direct means include (*i*) Suspension of the first crop of wheat and barley in the Nilgiris, Palnis and Devikulum area of Travancore for a period of 2-3 years, (*ii*) Rigorous destruction of self-sown plants and ratoon tillers of wheat and barley, 1-2 months before sowing, all over the hills and hilly tracts, and (*iii*) Postponement of the period of sowing in central Nepal to October.

Work on breeding of resistant varieties of wheat for cultivation in the hills should continue and the breeding of barley should also be started at an early date. 'Clean-up' of 'out of season' plants will have to be adopted in the hills even when resistant varieties are available.

It seems necessary, therefore, that the methods recommended above be adopted without delay in order to mitigate the huge loss of Rs. 60,000,000 or so caused by rusts of wheat and barley year after year.

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(Other references to foreign work on the dissemination of rusts by wind from places of earlier outbreaks are given in different parts of Section IV of this monograph)

* A cyclostyled copy of this report was kindly supplied by the author.

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